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ACQUISITION LOGISTICS GUIDELINES FOR IMPROVING THE ARGENTINE AIR FORCE WEAPON SYSTEM ACQUISITION PROCESS

THESIS

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Guillermo Abel Piuzzi

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Abstract

Increasing costs, complexity and demanded endurance have been typical characteristics of new weapon systems during the last decades. Meanwhile, severe contraction of defense budgets makes cost effective and well-planned acquisition crucial to ensure weapon system whole life supportability.

This qualitative research explores the role of acquisition logistics in the endeavor of purchasing effective, efficient, and supportable systems in four countries, namely the United States, Australia, Spain, and Portugal. Through a multiple case study, a set of concepts is extracted and adapted to be proposed as the basis of a prospective Argentine Air Force weapon system acquisition process review.

Suggested improvements reside in three areas. First, doctrine should incorporate the integrated logistics support, life-cycle cost, and reliability and maintainability concepts into the acquisition practices. Second, procedures should include well-defined supportability requirements and should recognize supportability as a core issue in every project phase. Finally, from the organizational standpoint, the Argentine Air Force should consider revising the composition, training, and chain of command of its acquisition teams in order to optimize and facilitate those groups' actions.

ACQUISITION LOGISTICS GUIDELINES FOR IMPROVING THE ARGENTINE AIR FORCE WEAPON SYSTEM ACQUISITION PROCESS

I. Background and Statement of the Problem

General Issue

During the last several decades, major defense acquisition programs have been demanding increasing amounts of economic resources, becoming unprecedentedly complex, and expanding their overall acquisition cycle (Gansler, 1989: 7-9). Furthermore, the end of the Cold War brought a steep contraction of defense budgets that extends almost worldwide (U.S. Arms Control and Disarmament Agency, 1996: 49).

A group of active buyer countries has been reacting to these changes in the defense market with refined efforts aimed to achieve the maximum benefit for the investment made. As the world's leading customer in the defense market, the U.S. has been undertaking a substantial reform to accommodate acquisition procedures to the changing environment. Broadly presented, this reform attempts to reduce defense acquisition costs and to achieve a flexible management approach for acquiring efficient and effective systems, under a total life cycle perspective (Department of Defense, 1997: Sec 4, 2; Department of Defense, 1996c: 1). Other major U.S. allies, like the United

Kingdom and Australia are reforming their acquisition procedures while watching the leader's performance.

Argentina is also affected by these general conditions of defense acquisition. However, there are two additional facts that contribute to shape a particular national environment. First, because the Argentine economy is still recovering from decades of severe turbulence, defense budgets have been particularly exiguous since 1985. Military expenditure to GNP ratio for Argentina in this period was 2.3 %, well below the 4.2 % world average ratio (U.S. Arms Control and Disarmament Agency, 1996: 49, 58). Second, the number of major defense systems purchased by the country from the 1982 Malvinas War to 1995 has been so small that neither trained nor experienced major system acquisition people remain in the services.

Recently, an incipient change for the better in the long-term Argentine Armed Forces' expectations of new equipment procurement appeared. These expectations are supported by several factors. First, eight years of sustained domestic economy growth at an average annual rate of 4.75% of the gross domestic product ended more than three decades of economic instability and stagnation (Ministry of Economy and Public Works and Services of Argentina, 1998). Second, on 18 March 1998, the Argentine Congress passed Law Number 24948 that authorizes a cumulative three percent growth in the defense budget for the next five years, gives incipient legal framework for multi-annual programs, and commits resources from the sale of Ministry of Defense superfluous estates to purchase new equipment (Argentine Congress, 1998). Finally, current Argentine military services participation in ten UN Peacekeeping Missions and in recent international operations -like the Gulf War- stresses the need for modern and interoperable materiel (United Nations, 1998). The Argentine Air Force (FAA from its Spanish name *Fuerza Aérea Argentina*) particularly needs to take advantage of this rising opportunity to recover from the substantial materiel losses suffered during the Malvinas War.

In addition to its challenging environment, the Argentine Air Force confronts an internal factor that jeopardizes the process of returning to reasonable levels of strength and readiness. Effectively, a strong perception exists that after fielding a newly acquired or modernized weapon system, supporting it efficiently and effectively becomes a titanic and uncertainly successful task. This negative perception is partially due to the lack of awareness and application of acquisition logistics activities during the processes of acquisition and/or alteration of major weapon systems.

While the Law Number 20124 provides the essential legal framework for acquisition, a set of procedures covering planning, execution, and control of the Argentine Air Force acquisition and modernization programs is contained in the Project Directive (Argentine Congress, 1973; Argentine Air Force, 1994:1). The Project Directive only delineates the primary tasks of a program manager, his operational and technical advisors, and the organizations involved in the process. The general references made to the acquisition logistics aspects are insufficient for assuring life-long support of the weapon systems.

These financially difficult times have disclosed weaknesses in the acquisition system, which are reflected in poor supportability performance. For the Argentine Air Force, the crisis generated by the acute lack of economic resources can be seen as the opportunity to identify and solve the reason for those weaknesses. Aiming at that objective, this research expects to be valuable to decision makers in the acquisition field, from the Argentine Air Force and from other organizations facing similar difficulties.

Statement of the Problem

Before stating the problem, it is important to recall that applied logistics can be divided in two sequential phases. Phase one or acquisition logistics involves planning and acquiring support for a system before it is deployed. Phase two or tactical/operational logistics encompasses every effort to support the system while the user is employing it. Moreover, acquisition logistics activities will make the difference between success and failure in tactical/operational logistics (Defense Systems Management College, 1997a: 2-3 to 2-6; Jones, 1987: 4-5).

The purpose of this study is to synthesize a set of guidelines to improve the Argentine Air Force's acquisition logistics process following the objective of achieving cost effectiveness in the tactical/operational logistics of newly acquired or upgraded weapon systems.

This work will be performed by exploring what the defense world has been doing in acquisition logistics during the last 15 years, while Argentina was almost absent from the market. A multi-case study procedure embodying acquisition of major defense systems in the United States, Australia, Spain, and Portugal is intended to produce a number of conceptual criteria for improving the current Argentine Air Force acquisition logistics.

Following Creswell's methodology for qualitative research studies (1994:70), the grand tour question for this research is how the state of the art indicates that acquisition logistics should be managed in order to achieve a smooth initial operation and good rates of readiness along the whole life of a weapon system, while minimizing the system life-cycle cost.

Scope of the Study and Investigative Questions

This study is intended, first, to discover a group of central issues in acquisition logistics that can help to improve the Argentine Air Force current procedures in this field. Second, it will explore how to adapt the discovered issues to the Argentine procedures, in an effort to move a step forward to prospective implementation approaches. Concepts will remain general enough to make them applicable to most of the major system acquisitions, as well as not to exceed the limits of time and resources of this thesis.

A set of investigative questions will keep the research on track during the exploration of the acquisition processes corresponding to the set of countries under analysis (Creswell, 1994: 70-72). Therefore, in the countries under examination:

1. Which support elements are addressed in every acquisition process?
2. How are supportability requirements stated in order to translate them into cost effective programs?
3. How are acquisition teams constituted to take charge of acquisition logistics issues?
4. How are acquisition teams organized in the decision making chain?
5. How are logistics and supportability considerations integrated into the system engineering process that frames a weapon system acquisition?
6. How is supportability measured and demonstrated in the acquisition process?

7. How is the increasing concern about costs influencing the necessary tradeoffs among performance, schedule, and cost?

Outline of Remainder of Thesis

Chapter I introduces the problem and the research investigative questions, while Chapter II describes and justifies the research methodology election. Grouped by country, the most important available literature is reviewed in Chapter III, to let the analysis begin in Chapter IV. Along Chapter IV, the set of investigative questions is answered for every one of the four countries studied. Finally, Chapter V presents the application of the concepts and lessons learned from this multiple case study to the Argentine Air Force circumstances.

The work is complemented by a number of illustrative appendixes, a glossary of acronyms and abbreviations, and a comprehensive bibliography.

II. Methodology

Introduction

This chapter first covers a number of definitions. Second, a discussion follows about why to use a qualitative model and what the basic assumptions of that model are. Third, the chapter considers the selection of case study as the design of choice among qualitative methods. Then, data collection sources and criteria for evaluating research quality are examined. Finally, the chapter discloses the study's limitations.

Definitions

Acquisition Logistics. "It is a multi-functional technical management discipline associated with the design, development, test, production, fielding, sustainment, and improvement modifications of cost effective systems that achieve the user's peacetime and wartime readiness requirements" (Department of Defense, 1997: Sec 4, 1).

Acquisition Logistics Objectives. "To ensure that support considerations are an integral part of the system's design requirements, that the system can be cost effectively supported through its life-cycle, and that infrastructure elements necessary to the initial fielding and operational support of the system are identified, developed and acquired" (Department of Defense, 1997: Sec 4, 1).

Supportability. "Degree to which system design characteristics and planned logistics resources meet system peacetime and wartime requirements. Supportability is the capability of a total system design to support operations and readiness needs throughout the system's service life at an affordable cost" (Department of Defense, 1997: Sec 4, 14).

Affordability. "A determination that the life cycle cost of an acquisition program is in consonance with the long-range investment and force structure plans" (Defense Systems Management College, 1997b: 5).

Readiness. "State of preparedness of forces or weapon system or systems to meet a mission or to warfight. Based on adequate and trained personnel, material condition, supplies/reserves of support system and ammunition, numbers of units available, etc" (Defense Systems Management College, 1997b: 75).

Qualitative versus Quantitative Paradigm

Not only, the nature of the problem, but also compliance of this study with most of the qualitative research assumptions determines that the general paradigm followed in this work be qualitative (Creswell, 1994: 145-146).

The nature of the problem is well suited for qualitative study because (Creswell, 1994:10):

- The subject of how to improve the current Argentine Air Force acquisition procedures is unknown enough to justify a descriptive study.
- The set of participating variables, most of them from the human behavior field, is complex and *a priori* unknown.
- Context is crucial for the understanding of the issues. Effectively, when studying a country acquisition procedures, it becomes essential to proceed not forgetting its economic, political, and cultural background.

On the other hand, most of the qualitative research assumptions presented by Merriam fit in this study (1988: 17-20). Namely,

- The primary concern of this research is about processes instead of outcomes or products.
- Interest stresses how acquisition people make sense of the structures and procedures they work with.
- The main instrument for data collection and analysis is the researcher; hence, human mediation of data is more important than in quantitative studies.
- The character of the study is essentially descriptive.
- The research process is inductive, where the researcher constructs patterns from individual pieces of information and details.

<u>Choosing a Qualitative Method</u>

Going deeper in the selection of the methodology and after reviewing the variety of available qualitative methods or strategies, case study rises as the logical choice.

A first analysis shows that the research questions are how-type questions, the researcher has no control over the considered events, and the focus is on contemporary occurrences. Then, according to Robert K. Yin, the recommended strategy is the case study (1994: 4-9).

However, Yin goes further clarifying the case study concept in a two-step definition (1994: 11-14):

1. A case study is an empirical inquiry that
   - investigates a contemporary phenomenon within its real-life context, especially when
   - the boundaries between phenomenon and context are not clearly evident.
2. The case study inquiry
   - copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result

- relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result
- benefits from the prior development of theoretical propositions to guide data collection and analysis.

Finally, the same author proposes five components of the case study research design (1994: 20-32), namely study question, propositions, unit of analysis, logic linking the data to the propositions, and criteria for interpreting the findings. Like a map for the explorer, these components help keep the whole research effort on track. The design components will be simultaneously presented and explained in the context of the present study:

- Study question. Our grand tour question presented in Chapter I is exposed in terms of how, which coincides with a descriptive case study design.
- Propositions. Propositions are intended to focus on aspects that the study should examine. They form a theoretical grid used to define what the study is looking for. In descriptive case studies like this, propositions convene a group of topics covering the essence of the description. Re-formulated as propositions, the group of investigative questions introduced in Chapter I is adopted as the set of propositions.
- Unit of Analysis. This component significance is synonym of explaining what the subject of the case study is. The unit of analysis explored is only one, the major defense system acquisition set of procedures. It should not be confused with the multiplicity of countries under investigation, which constitutes a multiple case study design. A multiple case study is not intended to represent a statistical sample from the population of acquisition processes in the World. The several

countries studied provide analytical and not statistical generalizations. In other words, the multiple case studies are committed to work as a replication technique that improves the external validity of the results.

- Logic Linking the Data to the Propositions, and Criteria for Interpreting the Findings. These are the two remaining components of the research design. Both conform to the data analysis phase in a case study. This study is looking for patterns in the acquisition procedures and related actions oriented to improve the logistics aspects of a defense major system acquisition. The assumption is taken that every country is striving to improve the logistic aspects of a weapon system insertion, and its subsequent life-long support, because readiness and ownership costs depend on that. The analysis of the facts and their context, plus the experience of the researcher provides criteria for interpreting the findings. Additionally, special attention is paid to coincident actions adopted by different actors.

Summarizing, the research will be conducted following the qualitative paradigm and using a holistic multiple-case study design. The unit of analysis will be the acquisition process and the different countries under evaluation will replicate the case study. The grand tour question and the investigative questions are depicted in chapter one.

Data Collection

The two main sources of evidence utilized in this research are documents and interviews.

Several types of documents were scrutinized. Among them, there were official policies and procedures; acquisition guides; books, and periodical articles about acquisition issues; and reports of related research. These documents cover acquisition procedures from the United States, Australia, Spain, and Argentina.

There are some other countries, like Portugal, whose procedures are not available in a written form, or Spain, whose acquisition documents are scarce. An open-ended interview was the tool chosen to capitalize on the knowledge of experienced Portuguese and Spanish officers about the acquisition logistics issues.

Countries for these case studies were selected according to the following procedure. First, a preliminary exploration determined a list of potential candidates from which information about their capital equipment acquisition system was reasonably available. Second, from that subset of countries, specific choices were taken according to the rationale that ensues. The U.S. acquisition system was selected because it is the most complex, advanced, and important in the World. Australia has a well-developed system, which process a relatively large volume of money annually. Spain and Portugal were picked up to represent Western European acquisition philosophy. From the military acquisition standpoint, Spain is representative of the medium-large European countries, and Portugal has the small-medium size that is closer to the Argentine case. Additionally, countries selected include large arms exporters and medium-small ones. Appendix A displays a set of figures showing comparative parameters from these four countries and from Argentina, which support the exposed reasoning.

A case study data base was compiled with the document references and the contents of the interview in order to facilitate subsequent access to the evidence sources, and increase research reliability (Yin, 1994:95).

Criteria for Evaluating Research Quality

According to Yin (1994:32-38), there are three tests applicable to descriptive case studies: construct validity, external validity, and reliability. Internal validity test is not included because it is considered applicable to explanatory case studies only. The three tests are intended to check the quality of the research design. There are specific "tactics" to avoid design flaws related to each one of the tests. The following plan will be used along the study to elude problems in construct and external validity, and in reliability,

- Construct Validity. In first place, a conscious effort will be developed during data collection to raise evidence about the same fact from multiple sources. When feasible, triangulation using documentation and open-ended interviews will be performed. When only documents were available, the use of more than one source will be attempted. Second, chains of evidence will be built to make possible double-checking the relationships between the case study database and the conclusions of the work.
- External Validity. Replication by means of a multiple-case study is going to deal with external validity threat. Stress will be put in findings that are common to two or more cases or countries.
- Reliability. Creating a case study database, where other researchers can find enough evidence to arrive to the same findings in the same case, will control this threat.

Limitations

The most important limitations of this study reside in the reduced number of countries analyzed, the scarce amount of written information in some of them, and the need of keeping this research focused on acquisition logistics aspects only.

Limits imposed by a thesis work forces to study just four cases. In addition to the countries selected, some others might have contributed desirable information. Additional interesting cases are Brazil, Canada, Chile, South Africa, United Kingdom, France, Germany, and Israel.

The amount of written information gathered from the U.S. and Australia is enough for this study purpose. However, the Portuguese case compelled to obtain data through a personal interview, due to its almost null acquisition logistics doctrine. The Spanish case required a mixed solution using its available doctrine, and telephonic/electronic mail interviews.

Finally, acquisition aspects other than acquisition logistics are only boarded minimally to keep the thesis into its boundaries. However, among other subjects, military acquisition offsets and ministry versus individual service decision making might be able to enrich the acquisition logistics discussion.

III. Literature Review

Introduction

This chapter configures an integrative type of literature review, which summarizes related literature background and previous research (Cooper, 1984: 11). Analysis of this material is broached in Chapter IV, where inductive thinking is going to construct results based on particular pieces of information contained in this literature review.

Literature is organized in categories to facilitate access and understandability. The underlying criterion for grouping documents is the country whose military materiel acquisition system is described in the document. First, literature about the Argentine major weapon system acquisition process is presented. Second, United States acquisition system documents are introduced. After that, documents covering Australia, Spain, and Portugal acquisition systems follow.

Since the majority of the documents are extensive, brief summaries of their general contents are presented and more details added exclusively on those acquisition logistics aspects relevant to answer the investigative questions. The list of documents in this review is not exhaustive, covering only those materials that represent the literature nucleus.

Argentina

Project Directive. (Argentine Air Force, 1994). The Argentine Air Force Project Directive assigns responsibilities and establishes criteria for planning, executing, and controlling major acquisition programs (1). It is the basic document used by program managers, major commands, and directorates to manage a project. Its prescriptions are general, and particularly vague when referring to acquisition logistics. The directive emphasizes eliminating duplication in research and development efforts, and investing money wisely (2).

The document recognizes two periods during the life of a project, and several phases inside the two periods (4). Appendix B reproduces and translates those periods and phases. The first period is the Planning and Development Period, under the responsibility of the Systems Directorate. The second is the Production and Deployment Period, which is usually managed by the Materiel Command. After the initial deployment of the new weapon system, the program manager and his personnel are dispersed, while the Materiel Command remains in charge of managing the rest of the life cycle. The milestone decision authority is the Air Force Chief of Staff (6).

Tasks and responsibilities corresponding to the program manager and his technical and operative assistants are depicted in the directive (Annex 6). Neither the program manager nor his aides have direct responsibility for acquisition logistics. Their tasks are limited to coordinating logistics aspects with the logistics organizations. Program manager tasks focus on administrative and system performance monitoring.

Materiel Command is left with the duty of defining and providing support for the new system in the second period, after System Directorate has developed the system (16). Neither support elements nor logistics measurements are clearly defined.

This document also provides a form to be used in preparing an operational requirements document. People elaborating an operational requirement are not encouraged to define support aspects of the system. Consequently, logistics aspects are not expressed as part of the system performance, and measurable supportability goals are not established (Annex 7).

United States of America

DoD Directive 5000.1 - Defense Acquisition. (Department of Defense, 1996a). It presents a set of principles guiding every defense acquisition program, a number of acquisition related definitions, and a description of the responsibilities of several key officials and key forums in the acquisition arena. DoDD 5000.1 emphasizes coordination among the three main DoD decision support systems in order to facilitate acquiring quality products. The three systems are the Requirements Generation System; the Acquisition Management System; and the Planning, Programming, and Budgeting System. In particular, this directive governs the Acquisition Management System.

A list of the principles stated by the document is presented in Table 1. Table 2 summarizes the key officials and forums involved in the acquisition process. Some of those points are discussed afterwards.

Integrated product and process development (IPPD) is a management technique using integrated product teams (IPT), which is encouraged by DoDD 5000.1. This technique improves weapon systems design, manufacturing, and supportability by an early and continuous integration of all acquisition activities, including logistics. Being at the roots of IPPD, integrated product teams are comprised of empowered officials representing every organization with interests in the program. These teams are entitled with the responsibility of making program decisions along the weapon-system life cycle. Empowerment and teamwork are central issues in DoDD 5000.1.

Table 1. DoDD 5000.1 Acquisition General Guiding Principles List

CATEGORY	GUIDING PRINCIPLE
Translating Operational Needs into Stable, Affordable Programs	Integrated Management Framework
	Integrated product and Process Development
	Program Stability
	Risk Assessment and Management
	Total Systems Approach
	Cost as an Independent Variable
	Program Objectives and Thresholds
	Non-Traditional Acquisition
	Performance Specification
Acquiring Quality Products	Event Oriented Management
	Hierarchy of Materiel Alternatives
	Communications with Users
	Competition
	Test and Evaluation
	Modeling and Simulation
	Independent Assessments
	Innovative Practices
	Continuos Improvement
	Legality of Weapons Under International Law
	Software Intensive Systems
	Environmental Management
Organizing for Efficiency and Effectiveness	Streamlined Organizations
	Acquisition Corps
	Teamwork
	Limited Reporting Requirements
	Tailoring
	Automated Acquisition Information
	Management Control

The total system approach criteria establishes that program managers have to optimize total system performance and life cycle cost. The term total implies the prime mission equipment -hardware and software -, its operational and maintenance crew, its support infrastructure, its related training, and the system interoperability and compatibility, among other factors.

Table 2. DoDD 5000.1 Key Official and Forum List

Key Officials	Deputy Secretary of Defense
	Under Secretary of Defense for Acquisition and Technology
	Under Secretary of Defense (Policy)
	Under Secretary of Defense (Comptroller)
	Secretary of each Military Department
	Vice Chairman of the Joint Chiefs of Staff
	Director, Operational test and Evaluation
	Assistant Secretary of Defense for C3I
	Director, Program Analysis and Evaluation
	Component Acquisition Executives
	Program Executive Officers
	System Command/Designated Acquisition/Materiel Command Commanders
	Program Managers
	Overarching Integrated Product team Leaders
Key Forums	Defense Resources Board
	Defense Acquisition Board
	Major Automated Information System Review Council
	Joint Requirements Oversight Council
	Cost Analysis Improvement Group
	Integrated Product Teams

Cost is recognized as such a powerful constraint that cost objectives and thresholds have to be defined and observed along the entire life cycle. Cost is now another independent variable in the decision making process, which trades off against performance and schedule.

When DoDD 5000.1 institutes criteria for organizing the acquisition force for efficiency and effectiveness, it mandates a short and streamlined chain of command for the program offices. From the highest decision authority -usually one of the top

Department of Defense officials- to the program manager there should be no more than two levels of review. Acquisition personnel training and certification are also mandatory. Other criteria stress how procedures have to be tailored to adapt to different environments, and how managers should focus control on results instead of on process.

The highest executive decision-makers for weapon system programs are top level DoD officials, such as the Under Secretary of Defense for Acquisition and Technology. The DoD leaders are advised by integrated product teams, like the Defense Acquisition Board and the Defense Resources Board.

DoD Regulation 5000.2-R - Mandatory Procedures for Major Defense Acquisition Programs (MDAPs) and Major Automated Information System (MAIS) Acquisition Programs. (Department of Defense, 1996b). This regulation establishes a set of mandatory procedures applicable to major acquisition programs in the DoD environment. The procedures implement DoD Directive 5000.1, Office of Management and Budget (OMB) Circular A-109, and other statutes. DoD 5000.2-R has six parts:

1. Acquisition Management Process:
2. Program Definition
3. Program Structure
4. Program Design
5. Program Assessments and Decision Reviews
6. Periodic Reporting

Part 1 - Acquisition Management Process. This part institutes a set of phases and milestones for managing major acquisition programs, and identifies milestone decision authorities (MDAs) for each type of program in order to reduce risk, facilitate the decision-making process, and warrant feasibility. The model must be tailored to satisfy particular characteristics of the major programs and may be used as a guide for non-major programs too.

Management is to be done by integrated product teams, which "shall function in a spirit of teamwork with participants empowered and authorized, to the maximum extent possible, to make commitments for the organization or the functional area they represent" (Part 1, 7). All genuinely interested disciplines and organizations should constitute the program IPTs and contribute to make correct decisions on time.

Part 2 - Program Definition. This part describes how broadly defined mission needs are transformed into operational requirements, which in their turn will originate a set of performance specifications for the program.

The user identifies and documents essential attributes of current deficiencies and opportunities to achieve new capabilities in a Mission Need Statement (MNS). Already into the program office framework, the user or user's representative must participate in improving and refining the MNS at each phase of the program, defining thresholds and objectives of performance measurements, and documenting them in an Operational Requirements Document (ORD). It is the ORD where the program manager will look for a set of Key Performance Parameters (KPPs), which after validation by the Joint Requirements Oversight Council (JROC), will help to shape the Acquisition Program Baseline (APB).

Being an essential part of program performance specifications, supportability factors should not be termed as independent logistics requirements. They must be integrated with the other performance requirements.

Appendix II of the DoD 5000.2-R details the mandatory format for an Operational Requirements Document, which titles are displayed in Table 3. Some of the titles deserve further comments. The Logistics and Readiness title in the Capabilities Required section refers to a set of quantitative, operational, and output-oriented requirements for "mission-capable rate, operational availability, frequency and duration of preventive or scheduled maintenance actions, etc. " in wartime and peacetime (Appendix II, 2). The Program Support section defines "support objectives for initial and full operational capability" (Appendix II, 3), and includes maintenance planning; support equipment; human system integration; provisioning; and packaging, handling, and transportation characteristics, among other support issues.

Part 3 - Program Structure. This part details a set of program elements that are crucial in achieving success. These elements are the program goals, the acquisition strategy, the test and evaluation strategy, and the life-cycle resource estimates.

While an objective and a threshold define each **program goal,** a set of crucial cost, schedule, and performance program goals constitute the Acquisition Program Baseline (APB). The number of parameters defined in the APB is to be held to a minimum compatible with the complete definition of the program operational suitability, schedule, and cost. APB initial determination and its subsequent revisions are proposed by the program manager and approved by the Milestone Decision Authority (MDA). Additionally, the program manager proposes the next phase exit criteria to the MDA, at each milestone review. Exit criteria do not duplicate APB thresholds and objectives, but they serve as progress monitors in the program development.

Table 3. Operational Requirements Document Titles

Section	Issues
1. General Description of Operational Capability	
2. Threat	
3. Shortcomings of Existing Systems	
4. Capabilities Required	a. System Performance
	b. Logistics and Readiness
	c. Other System Characteristics
5. Program Support	a. Maintenance Planning
	b. Support Equipment
	c. Human Systems Integration
	d. Computer Resources
	e. Other Logistics Considerations (provisioning, PH&T)
	f. C4I
	g. Transportation and Basing
	h. Standardization, Interoperability, and Commonality
	i. Mapping, Charting, and Geodesy Support
	j. Environmental Support
6. Force Structure	
7. Schedule Considerations	

An **acquisition strategy** is a guide for executing the program from cradle to grave. It is developed and updated by the program manager, and approved by the MDA. An event-driven acquisition strategy includes every critical event in the development, testing, production, and life-cycle support of the program.

One of the acquisition strategy aspects that is particularly relevant for this research is cost as an independent variable (CAIV). According to DoD 5000.2-R, the strategy should establish procedures to set, manage, and achieve aggressive and feasible cost objectives. A Cost/Performance IPT should be created early to advise the program manager about the best cost/performance tradeoffs. A good acquisition strategy should recognize that the best opportunity to reduce life-cycle costs is at the beginning of the acquisition process, and that providing maximum flexibility to PM and contractors to make cost/performance tradeoffs is highly beneficial.

Test and evaluation programs should harmonize all kinds of test, modeling, and simulation efforts as a coherent cascade of activities, oriented to provide risk mitigation and model validation data, to asses technical performance achievements, and to determine system operational effectiveness. Starting at Phase 0, planning for test and evaluation must specify quantitative measures of effectiveness (MOEs) and of performance (MOPs), scenario descriptions, resource needs, and test limitations. If possible, combined developmental and operational tests would be able to save resources. When operational tests proceed, one of the mandatory procedures stipulates that "typical users shall operate and maintain the system or item under conditions simulating combat stress and peacetime conditions" (Part 3, 17).

The last vital element in a program success is early, accurate, and continually updated **life-cycle resource estimation**. This resource estimation includes life-cycle-cost estimation and labor estimation. For major programs, not only PM cost estimations are necessary, but also an independent estimate performed usually by the Office of the Secretary of Defense Cost Analysis Improvement Group. Moreover, a manpower estimate reporting personnel needs to operate, support, maintain, and train during the whole life of the program is necessary to proceed into Phase II.

Part 4 - Program Design. This part depicts an integrated, complete, and conventional scheme to perform a system life-cycle design. The central issues in program design are System Engineering, and Integrated Process and Product Development, including Integrated Product Team.

System engineering (SE) is a top-down iterative process encompassing Requirements Analysis, Functional Analysis and Allocation, Design Synthesis and Verification, and System Analysis and Control phases. SE goals are to transform operational needs into integrated system design solutions, suitable throughout the entire life of a system; to assure compatibility, interoperability and integration of every physical and functional interface; to produce a system that positively satisfies its original requirements; and to identify and control technical risks. Some areas of design that are important to include in the system engineering process are also particularly interesting for this research, namely Acquisition Logistics, Open Systems Design, Reliability, Availability and Maintainability, and Human Systems Integration.

The program manager is responsible to perform **acquisition logistics** management from the beginning of an acquisition in order "to ensure the design and acquisition of systems that can be cost-effectively supported and to ensure that these systems are provided to the user with the necessary support infrastructure for achieving the user's peacetime and wartime readiness requirements" (Part 4, 4).

Supportability analyses gives the basic information to develop related system specifications and to manage support along the life of the program. The program manager must perform it at the outset and refresh it throughout the program development. A support concept has also to be specified and updated in a similar way.

An **open systems approach** means that "for Government only" specifications and standards should be avoided as much as possible in developing systems and their support resources.

Trying to achieve operational requirements and decrease costs of ownership, the program manager shall include **reliability, availability, and maintainability** (RAM) tasks since the program initiation, in order to influence design, development, manufacturing, and test activities. Reliability, maintainability, and availability are to be quantitatively defined, measurable, and applicable to every part of the system, including support and training equipment. Reliability requirements include mission and logistic reliability; maintainability requisites involve servicing, preventive, and corrective maintenance; and availability addresses system readiness.

Human system integration activities are intended to reduce or eliminate system features demanding excessive training or workload on operators or maintainers. These system features generate high rate of critical errors and/or safety hazards, which in the end affect negatively the program's performance and life-cycle cost. Early in the acquisition process, the program manager shall address human system integration factors to shape design and/or acquisition accordingly.

Part 5 - Program Assessments and Decision Reviews. Part 5 defines the mechanism of performing periodic assessments and milestone decision reviews through the work of different teams. Composition, main roles, and meeting frequency corresponding to the most important forums in the acquisition process are depicted in this section. The groups described are Defense Acquisition Board; Major Automated Information Systems Review Council; Overarching, Integrating, and Working Integrated Product Teams; Joint Requirements Oversight Council; and Cost Analysis Improvement Group.

Part 6 - Periodic Reporting. This part enumerates and describes the periodic reports that render cost, performance, and schedule; test and evaluation; and contract management information to the Milestone Decision Authority. These reports make possible the program oversight and decision making process.

MIL-HDBK-502 - Department of Defense Handbook: Acquisition Logistics. (Department of Defense, 1997). It provides direction on acquisition logistics as a discipline integrated to the systems engineering process. The scope of MIL-HDBK-502 covers acquisition of every materiel and automated information system, whatever acquisition strategy is used. The handbook is organized in sections, namely:

- Section 1: Scope
- Section 2: Applicable Documents
- Section 3: Definitions
- Section 4: Systems Engineering and the Acquisition Process
- Section 5: Supportability Analyses
- Section 6: How to Develop Measurable and Testable Supportability Requirements
- Section 7: Support Data
- Section 8: Logistics Considerations for Contracts
- Section 9: Integrated Product Team Setup and Involvement
- Section 10: Notes

This literature review concentrates on sections four to nine.

Section 4 - Systems Engineering and the Acquisition Process. This section describes the DoD systems acquisition process and the systems engineering approach used as a basic tool in the acquisition process. Because supportability analyses should be embedded in the acquisition process, several issues related to supportability arise in this section.

The acquisition process lasts throughout the life cycle of a system and is governed by the acquisition management process. Figure 1 depicts the phases and decision milestones that constitute the acquisition process.

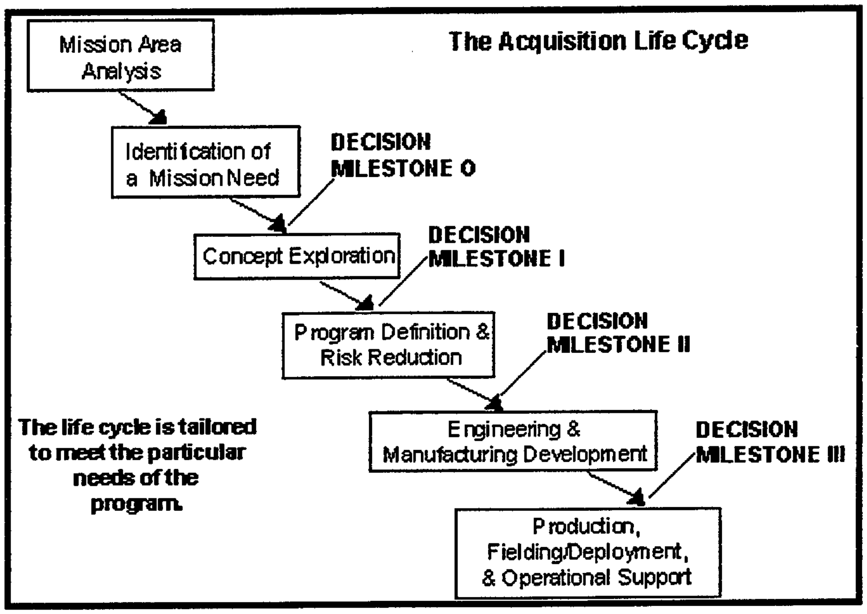


Figure 1. Acquisition Management Process or Acquisition Life Cycle (Sec 4, 3)

Considering that the amounts of flexibility in the hardware, software, and support designs of the total system vary according to the type of acquisition - modification, commercial item, non-developmental item (NDI), or development -, there are different supportability analysis approaches to be followed in each case. However, it is a general rule that "integrating supportability requirements into system and equipment design requires that designers be oriented toward supportability objectives from the outset" (Sec 4, 8).

The systems engineering approach integrates the hardware, software, and logistics resources design in a balanced system solution oriented to satisfy an operational need. The systems engineering approach follows a top-down iterative logic of design refinement, from Requirements Analysis to Functional Analysis/Allocation, and from there to Synthesis. Simultaneously, a bottom-up loop, named System Analysis and Control verifies coherence between design and requirements. It is precisely at this point in the process where program cost, schedule, and performance tradeoffs take place, and design alternatives are evaluated. Figure 2 depicts the systems engineering process flow.

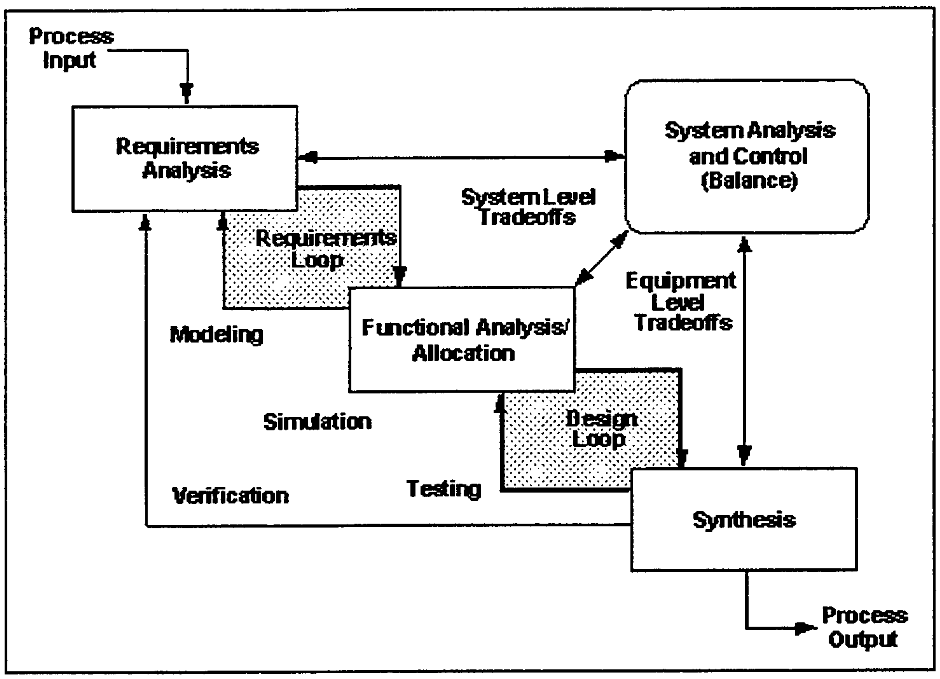


Figure 2. Systems Engineering Process Flow (Sec 4, 13)

Acquisition logistics is a discipline of systems engineering, which aims to define the optimal set of planned logistic resources for a system. Acquisition logistics analyzes the system design characteristics requiring operational support, and tries to match these requirements to the planned logistics resources. That degree of matching in peacetime and wartime is defined as supportability. There are two generally accepted measures of supportability: operational availability or readiness, and life cycle cost or affordability. Additionally, three omnipresent supportability criteria should be part of the total design effort, namely cost, equipment readiness, and personnel constraints.

Section 5 - Supportability Analyses. This section characterizes supportability analyses and describes their goals. These goals are, first, "to ensure that supportability is included as a system performance requirement", and second, "to ensure that the system is concurrently developed or acquired with the optimal support system and infrastructure" (Sec 5, 1).

Supportability analyses are a variety of related analyses, such as repair level analysis, reliability predictions, failure modes, effects, and criticality analysis, life cycle cost analysis, among others. To be effective, they have to be performed at each stage of the systems engineering iterative process. Furthermore, as the systems engineering process repeats at any phase of the acquisition life cycle, supportability analyses are also redone, adapted to the particular set of objectives and characteristics of each phase. The supportability issues of these successive iterations are explained in this section.

In order to ensure supportability is included as a performance requirement, the operational requirements document should contain user defined operational and support concepts. In the process, those operational needs that demand support provisions - called supportability factors - have to be analyzed. The typical factors are deployment, mobility, mission frequency and duration, human capability and limitations, and anticipated service life.

To ensure optimal support system design - the second supportability analyses goal - two different approaches are depicted depending on the type of acquisition program, commercial or developmental. However, both approaches are framed by the systems engineering process applied primarily in the phase two and three of the acquisition life cycle.

Section 6 - How to Develop Measurable and Testable Supportability Requirements. Scrutinizing the logistics contents of the Operational Requirements Document, section six demonstrates the importance of relating every logistics requirement to an operational need. It also stresses that both operational and logistics requirements must be conceived simultaneously. "Only when logistics is an afterthought should it cause delay" (Sec 6, 5). An early tradeoff policy between logisticians and design engineers is seen as the most effective approach to balance design objectives and supportability requirements. Teamwork is a crucial factor in integrating acquisition logistics into the systems engineering process.

Section 6 advocates developing performance requirements instead of detail requirements. "Requirements must express what the desired outcome is, but must not direct how to achieve that outcome" (Sec 6, 5). How to term performance requirements fills a considerable part of the section. Additionally, how to develop a good set of metrics is explained, too.

Supportability design factors that should be present in any program can be discriminated in several categories, namely:

- System reliability
- System maintainability

- Maintenance burden
- Built in failure isolation capability
- Transportability requirements

Section 7 - Support Data. This section provides guidance about what type of support data should the Government ask from contractors. The general idea is to minimize the only-for-the-Government requirements, avoid regulating contractor's in-house procedures, and encourage the use of electronic data interchange, on-line access, etc. DoD 5000.2-R and MIL-PRF-49506 provide the basis for this section's discussion. Table 4 displays a summary of typical support data and their sources. The rest of section seven focuses on the uses of Logistics Management Information Summaries and Worksheets.

Table 4. Sources for Support Related Data

Sources for Support Related Data
Consider obtaining these types of data:
Reliability Availability and Maintainability (RAM)
Logistics Management Information (LMI)
Technical Publications
Transportability
Training
From these kinds of sources:
Industry standards
Other commercial or military customers
LMI specification summaries
Contractor's in-house data

Section 8 - Logistics Considerations for Contracts. This section presents the standard contract format and analyzes the logistician's role in preparing every single part of a contract. Logistic contributions to the contract are substantial, and cover practically all the contract sections. However, it is not a work to be done in isolation by the logisticians; close cooperation is expected among logisticians, program manager, users, design engineers, and contracting people.

Two interesting aspects of this process from the standpoint of this research are the Statement of Work (SOW) and the Statement of Objectives (SOO) prescriptions. After acquisition reform, SOWs must be termed as a concise list of performance requirements, instead of the long list of "how to" prescriptions of the past. Another approach, followed by the US Air Force, consists of submitting a brief set of product-oriented goals instead of performance-oriented requirements to the offerors, which is called statement of objectives. Then, contractors have the opportunity of developing a statement of work embodying more innovative and cost-effective solutions, and submit it to the PM for approval.

Section 9 - Integrated Product Team Setup and Involvement. This section describes how Integrated Product Teams (IPTs) should function in the DoD Integrated Product and Process Development (IPPD) environment. It also presents IPT's particular characteristics for acquisition logistics team members.

All three types of IPTs - overarching, working and program IPTs - should follow a set of general rules of operation, namely open discussions with no secrets, empowered team members, consistent and success-oriented proactive participation, continuous up-the-line communications, reasoned disagreement, and early raised and resolved issues.

Acting as experts on their field of knowledge, logisticians on integrating IPTs have additional responsibilities, which are to participate actively, communicate their points of view, always challenge requirements, and pay attention to details. Moreover, a good logistician must always keep his total-life-cycle focus, create quantifiable and testable supportability requirements, and be willing to accept tradeoffs in the program acquisition process.

Section 9 does not provide concrete formulae to define IPT's composition. However, it becomes clear that representatives from every organization that could influence the product along its lifetime should be included in the IPT's structure, including those from organizations that could raise objections to the program.

Acquisition Logistics Guide. (Defense Systems Management College, 1997a). This is a training aid prepared by the Defense Systems Management College, which is based on the latest version of the DoDD 5000 series. It is organized in 5 parts and 29 chapters. This literature review highlights only those aspects of this extensive guide that complement previously discussed references.

The guide prescriptions are neither mandatory nor part of the military doctrine; however, they are referenced because program managers and other acquisition officials use them as study material in their professional education.

Part I (Chapters 1 to 4) - Introduction. This part presents the historical background of logistics in the U.S., proposes a set of logistic definitions, describes the current DoD acquisition policy, and presents generalities about Integrated Product and Process Development.

After discriminating between acquisition logistics and tactical/operational logistics, Chapter 2 defines a set of functions that are the core activities of the acquisition logistics integrated product team. Table 5 summarizes these functions. The term support embodies every one of the support elements described in chapter seven of the guide, which in their turn correspond to the traditional ten integrated logistics support elements.

Table 5. Acquisition Logistics Functions

Identify	the support requirements.
Advocate	the best design alternative.
Influence	detailed design.
Refine	at the same pace and depth as the rest of the IPTs.
Foster	test and evaluation of both system and support system.
Acquire	the support.
Provide	the support to the user.
Improve	the support.

Part II (Chapters 5 to 11) - The Logistics Program. From the standpoint of this research, this part contains the most relevant information in the Acquisition Logistics Guide. First, part two reviews the Defense System Acquisition Management Process stressing the role of logisticians and risk management in each phase. Second, the ten traditional support elements are introduced and described. Then, the document presents logistics related aspects of the systems engineering process and depicts supportability analyses. After that, a characterization of the different types of logistics plans follows, before examining reliability, availability, and maintainability issues. Finally, logistics aspects of test and evaluation are explained. The next several paragraphs discuss and summarize some paramount issues introduced by this part of the guide.

Chapter 6 outlines the Logistics Manager (LM) main activities before Milestone 0 and during Phases 0, I, and II, which are summarized in Table 6. The driving idea is to plan and execute logistics actions as early as possible in the acquisition process.

Table 6. Logistics Functions to be Performed during the Defense Systems Acquisition Management Process

Phase	Functions
Before Milestone 0	Including logistics support constraints in the MNS. Investigating lessons learned and improvement targets. Identifying potential logistics strategies. Performing early support analysis activities, such as developing a support concept.
0	Developing the acquisition logistics strategy. Refining initial supportability planning and LCC estimates. Keeping in step with emerging design. Providing logistics involvement in PDRR contract management and IPT reviews. Preparing logistics section of EMD contract package. Considering support analyses, such as standardization and interoperability.
I	Implementing acquisition logistics strategy. Refining initial supportability planning and LCC estimates. Keeping in step with emerging design. Providing logistics involvement in PDRR contract management and IPT reviews. Preparing logistics section of EMD contract package. Considering support analyses. Initiating post-production planning.
II	Implementing acquisition logistics strategy. Continuing to refine supportability planning and LCC estimates. Commencing Test & Evaluation of logistics. Continuing logistics involvement in EMD contract management and IPT reviews. Preparing the logistics sections of the next-phase contract package. Considering support analyses, such as finalizing post-production support plans.

The logistics manager must not only be concerned about cost and schedule risks, but also about some crucial support risks such as accomplishing reliability, availability, and maintainability (RAM) thresholds, completing a capable logistics support structure, and fielding the system in the right place, quantity, and time. To manage these risks successfully, the logistics manager should evaluate carefully what negative occurrences may arise, their probabilities, and their effects on cost, schedule, and performance. After this evaluation, decisions are to be made to reduce the likelihood of adverse events; minimize negative effects on cost, schedule, and performance; or simply accept the risk.

When addressing supportability, a natural concern affecting acquisition people is whether they are exhaustively covering every related aspect. Chapter 7 recreates the traditional set of ten support elements, which covers the whole spectrum of system supportability connotations. After acquisition reform, support elements lost their role as subjects of support requirement specifications, which from that time must be expressed in terms of program performance specifications. However, support elements remain important as the underlying conceptual foundation of supportability. The ten primary logistics elements are Maintenance Planning; Manpower and Personnel; Supply Support; Support Equipment; Training and Support; Technical Data; Computer Resources Support; Facilities; Packaging, Handling, Storage, and Transportation; and Design Interface. Other additional functional elements to be considered by the logisticians are Reliability, Maintainability, and Availability; Life Cycle Cost; and Logistics Support Resource Funding.

Chapter 8 stresses that logistics is an element in the System Engineering (SE) process. Because SE tries to achieve balance among performance - including readiness and supportability, risk- cost, and schedule, logistics considerations must be integrated into the iterative mechanics of SE in order to:

Produce readiness objectives that will be challenging but attainable.
Identify realistic reliability and maintainability requirements to achieve these objectives.
Identify support and manpower drivers.
Assign appropriate priority to logistics element requirements in system design tradeoffs (8-1 to 8-2).

Meanwhile, when most likely conflicts between design and supportability issues appear, the logistician must compel a compromising solution that recognizes equal importance of readiness, supportability, program schedule, and performance issues.

Supportability analyses embody a series of analysis performed during the acquisition management process, which are listed in Table 7.

Table 7. Supportability Analyses

-	Reliability, Maintainability, and Availability Analysis.
-	Maintenance Planning Analysis.
-	Repair Analysis
-	Support and Test Equipment Analysis
-	Supply Support Analysis
-	Manpower, Personnel, and Training
-	Facilities Analysis.
-	Packaging, Handling, Storage, and Transportation Analysis.
-	Post-production Supportability Analysis
-	Redundancy Analysis.
-	Failure Modes and Effects Criticality Analysis (FMECA).
-	Reliability Centered Maintenance Analysis.
-	Test, Analyze, Fix, and Test (TAFT)
-	Failure Reporting, Analysis, and Corrective Action System (FRACAS).

Chapter 9 depicts the three essential logistic plans aimed to effectively support the system when fielded. They are the Top-Level Support Plan, the Post-Production Support Plan, and the Fielding/Deployment Plan. The top-level plan is the main logistics document, which purpose is to plan the system support integrally, addressing each logistics element. The plan encompasses the acquisition logistics strategy, records of every logistic program decision, precedents for logistics contribution to procurement documents, and requirements, tasks, and milestones.

RAM issues are treated in chapter 10. The guide echoes DoD 5000.2-R establishing that RAM purposes are to "increase combat capability/effectiveness and reduce life-cycle ownership" (Ch 10, 2). The process of translating a user's measure of perceived RAM into design specifications understandable to designers is described, as well as several procedures to assess RAM.

Finally, Chapter 11 describes logistics test and evaluation (T&E). T&E activities start at Phase 0 and extend throughout the whole acquisition process, following a Test and Evaluation Master Plan (TEMP). Logistics T&E activities are part of the TEMP and the Top-Level Support Plan too. Logistics T&E objectives are intended to demonstrate that the system is supportable under wartime conditions, achieves readiness objectives during peacetime, and does not exceed life cycle-cost thresholds. There are three types of T&E activities:

- Development Test and Evaluation (DT&E): It is part of the design and development process. It evaluates whether performance specification thresholds and objectives are achieved.
- Operational Test and Evaluation (OT&E): It assesses operational effectiveness and suitability of the system under highly realistic conditions. Typically performed during the engineering and manufacturing development phase, OT&E are conducted by an independent agency.
- Supportability Assessment: It is performed as part of DT&E and OT&E, and after the system deployment. These assessments evaluate the influence of each logistics element on system readiness and LCC.

Part III (Chapters 12 to 17) - Logistics Resources and Tools. This part is mostly devoted to cost issues in acquisition logistics. It goes deeply in the LCC and CAIV concepts and presents logistics programming, budgeting, and contracting information.

Acquisition reform brought a substantial emphasis on programmatic cost management. Not only the importance of LCC in program decision making increased, but also it is now mandatory to consider costs thresholds and objectives as independent decision variables in major acquisition programs. This new concept - cost as an independent variable - is oriented to reduce LCC, and to achieve aggressive but realistic cost objectives. CAIV makes use of a series of known techniques or levers. Among them are cost/performance tradeoffs, competition, concurrent engineering and IPPD, use of commercial specifications, and user involvement in setting goals. Now, performance and schedule are tradable against cost in any major acquisition program. Flexibility plays a fundamental role in the PM, contractors, and users negotiations to achieve an affordable product that satisfies the bottom line performance requirements.

Part III highlights the importance of assessing and minimizing LCC from the outset of the program, and recurrently adjusting the estimations at each milestone or change proposal. Besides, the impact of any cost/performance tradeoff on LCC is inversely related to the degree of program maturation, i. e. , most significant impact is achieved before milestone I. The accepted methodologies, techniques, and models to calculate LCC are introduced in Chapter 12, as well as sources of data.

Part IV (Chapters 18 to 23) - Special Topics. Part IV treats the logistics subjects corresponding to information technology, contractor support and warranties, software, commercial and non-developmental items, joint programs, and international programs.

<u>Part V (Chapters 23 to 29) - Implementing Logistics.</u> Part V pictures the logistics tasks to be performed during phase three of the acquisition life cycle. Production, deployment/fielding, post-production, modifications, and disposal support actions are covered here.

In the production phase, logistics objectives are "to ensure that approved supportability design requirements are achieved in the early production articles and that planned logistics support resources are defined and adequately funded to achieve the system readiness objectives" (Ch 24, 1). Support activities during production are depicted in Table 8.

Table 8. Support Activities during Production

- Verify R&M objectives
- Monitor production of prime and support hardware/software/GFE
- Coordinate and provide all items of support
- Update support and deployment planning
- Obtain operational feedback as soon as possible
- Consider logistics implications and testing of ECPs
- Monitor training programs

Deployment/fielding stage is a challenging time when logisticians should put in practice a complex set of activities, which have been under preparation since the concept exploration phase. Provisions for every logistics element at operational and depot levels, as well as for interim contractor support, and for adequate funding must be accurately and coordinately accomplished in order to turn over the system. It is also time for Follow-On Test and Evaluation (FOT&E), which is usually performed at the first unit equipped. An IPT devoted to assist the user is normally added to the program manager office.

The logistics objective in post-production and operational time is to comply with readiness and LCC thresholds simultaneously. Considering the ever-increasing life span of defense systems, a PMO permanent task should be to evaluate support problems arising, especially those related to spare and repair part sources. Table 9 shows a set of measures aimed to increase supply and decrease demand on items suffering loss of production sources.

Finally, Chapter 29 emphasizes the value of early planning to reduce costs of system disposing. There are three different demilitarization approaches, which in decreasing order of preference are Recycling/Reuse, Reprocessing, and Disposal in a landfill. Decisions made by the PM during phases I and II will be determinant of the hazardous waste generation at the final stage. The PM again must ensure that demilitarization be a controlled process that minimizes environmental, security, safety, and health adverse consequences.

Table 9. Logistics Actions to Reduce Impact of Loss of Production Sources

Spare and Repair Parts Actions	
Increase Supply	**Decrease Demand**
• Develop a re-procurement technical data package and alternate production sources. • Withdraw from disposal source. • Procure life-of-type buy. • Seek substitute parts. • Redesign system to accept standard components if not interchangeable. • Purchase plant equipment; establish an organic depot capability. • Subsidize continuing manufacturing. • Draw (cannibalize) from marginal, low priority systems.	• Restrict the issue to critical applications in support of combat essential items. • Phase out less essential systems employing the same parts. • Restrict issue to system applications where no substitute is available. • Accelerate replacement of the system.

Acquisition Strategy Guide. (Defense Systems Management College, 1998). The guide is intended to gather the necessary information that program managers need to structure, develop, and execute an acquisition strategy. The document is organized in four chapters, which describe the acquisition strategy characteristics and critical elements, as well as the process of developing, documenting, and executing it.

Acquisition strategy must be developed during Concept Exploration Phase and continually updated along the acquisition life cycle. According to this guide, an acquisition strategy primary goal is "the minimization of the time and cost of satisfying an identified, validated need; consistent with common sense, sound business practices, and the basic policies established by DoDD 5000.1" (Ch 1, 1). Pursuing that goal, acquisition strategy must integrate logistics support and LCC aspects among its principal issues. In consequence, logisticians have to be part of the Strategy Development Team since the very beginning of the acquisition process (Phase 0), as depicted in Table 3-1 of the Acquisition Strategy Guide.

Reducing Life Cycle Costs for New and Fielded Systems. (Department of Defense, 1995). As the U.S. Under Secretary of Defense (A&T), Dr. Paul Kaminski signed this memorandum establishing a new "policy and strategy to develop and field affordable weapon systems that are responsive to the user's needs" (1). The new concept introduced here is called Cost as an Independent Variable (CAIV), which is considered the DoD version of best commercial business practices.

The document first sets a context in which the user of the weapon system participates actively in establishing and optimizing the program goals. Of particular interest is the inclusion of the user in the early process of cost-performance tradeoffs, where non-essential performance requirements should be traded to achieve an affordable balance among capacities and schedule. In this context, cost must be managed as an independent variable, by means of:

- Setting realistic but aggressive cost objectives early in each acquisition program.
- Managing risks to achieve cost, schedule, and performance objectives.
- Devising appropriate metrics for tracking progress in setting and achieving cost objectives.
- Motivating government and industry managers to achieve program objectives.
- Putting in place for fielded systems additional incentives to reduce operating and support costs. (5)

As the memorandum explains, there are not many innovative elements in this policy, but integration and enforcement of a set of standing policies and procedures should be able to install cost as an independent variable in the DoD environment. The rest of the document enacts some specific ways of executing the actions listed in the previous paragraph.

Introduction to Defense Acquisition Management. (Defense Systems Management College, 1996). This handbook is intended to present an introduction to the broad aspects of the defense system acquisition environment. The document is useful because it avoids small details to provide an account of the big elements in the acquisition world.

Chapter 1 provides several term meaning clarifications; an explanation of the roles of Congress, the Executive Branch, and Industry in defense acquisition; and an overview on the set of documents giving legal framework to the acquisition process. Chapter 1 presents a clear distinction between acquisition and procurement. While acquisition "includes research, development, test and evaluation, production, procurement, and operations and support," procurement is merely "the act of buying goods and services for the Government. " Then, procurement is included in the more comprehensive acquisition.

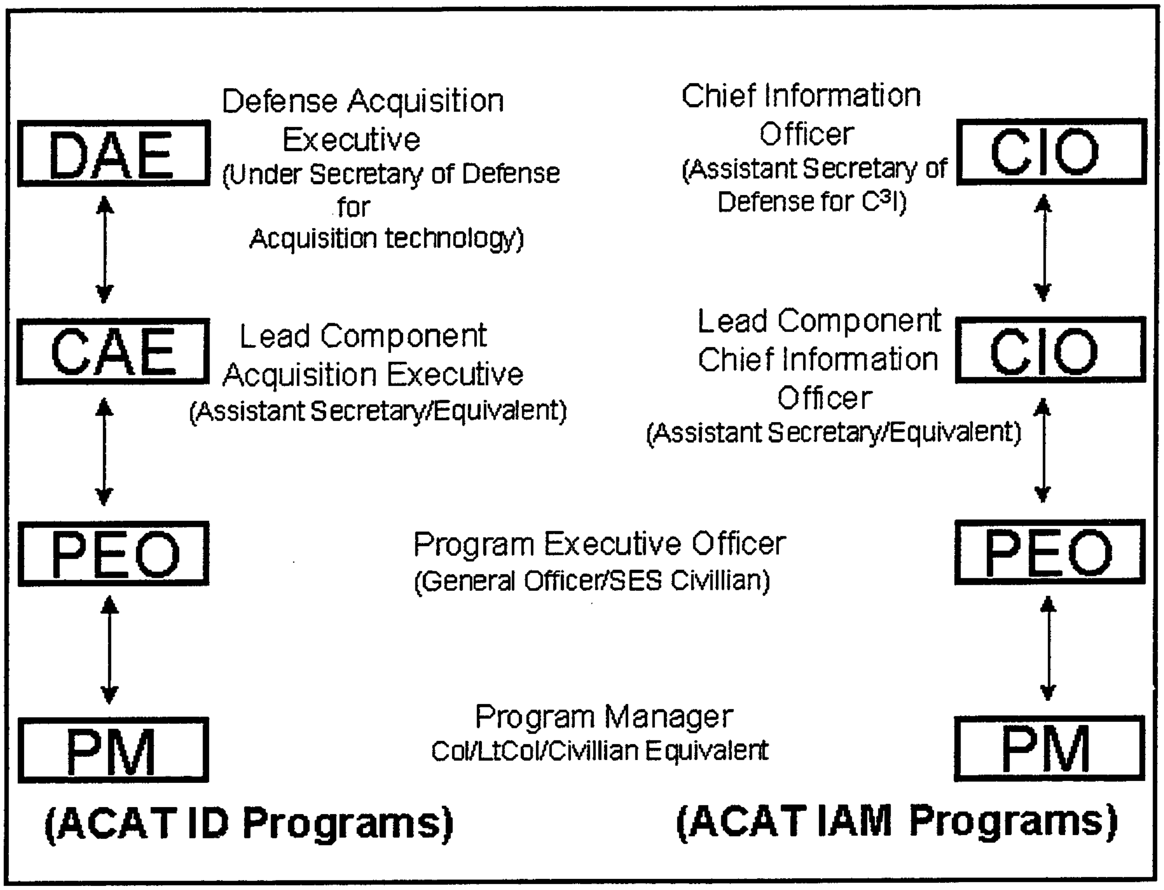
Chapter 2 is devoted to describe the acquisition reform process, while chapter 3 overviews the DoDD 5000.1 and DoD Regulation 5000.2-R.

The role of every important defense acquisition management organization appears in Chapter 4. Figure 3 reproduces the DoD Acquisition Authority Chain presented in the document. Additionally, the roles of Overarching and Working IPTs are explained, as well as it is the Defense Acquisition Board (DAB) one.

Chapters 5, 6, and 7 describe the requirement generation process, the acquisition management process, and the resource allocation process respectively. Chapter 8 lists a series of business and technical functions of the acquisition program manager.

Chapter 9 contributes two important definitions when describes the special role of the PM, which stress the system-cradle-to-grave character of its work.

> Program Management is the process whereby a single leader exercises centralized authority and responsibility for planning, organizing, staffing, controlling, and leading the combined efforts of participating/assigned civilian and military personnel and organizations, for the management of a specific defense acquisition program or programs, through development, production, deployment, operations, support, and disposal.
>
> Program Management provides a single point of contact who is the major force for directing the system through its evolution, including design, development, production, deployment, operations and support, and disposal...The PM has only one responsibility - managing [a] program - and accountability is clear.



Note: ACAT ID is a category I major defense acquisition program, which MDA is USD (A&T).
ACAT IAM is a category I major automated information system acquisition program, which MDA is the OSD Chief Information Officer.

Figure 3. DoD Acquisition Authority Chain (7)

Australia

Future Directions for the Management of Australia's Defence. (Australian Department of Defence, 1997b). This report contains the findings and recommendations produced by the Defence Efficiency Review (DER). The DER was created by the Minister for Defence to "identify key management processes across the Defence program structure, assess the efficiency and effectiveness of current management and financial processes, and make recommendations for reforming Defence management and financial process" (1). This document plays a crucial role in the Australian Defence Reform Program because its recommendations are used as a basis for the reforming actions launched by the Honorable Ian McLachlan, former Australian Minister for Defence on April 11, 1997 (McLachlan, 1999: 1). The report covers the whole defense environment; nonetheless, only those subjects related to the purpose of this research are presented here.

In the acquisition arena, the DER recognizes that effectiveness is a paramount objective due to the large cost of poor procurement along the whole life cycle. Consequently, the report establishes that the acquisition corps must be totally professional and educated. Acquisition must be managed by a joint organization with a military proportion dropping from current 30 per cent to approximately 10 per cent of the total. More stability and expertise are pursued by the increased quota of civilian employees in acquisition, without forgetting that military personnel's operational and logistical experience continues to be crucial (25-26).

Training in acquisition subjects should be managed by an ad-hoc central organization. Project management must encourage teamwork among experts from a variety of areas, particularly logistics. Besides, the Acquisition Executive is to be organized in functional groups - surface ships, submarines, aircraft, missiles and ammunition, etc - instead of the traditional Navy, Army, and Air Force divisions. The goal is a more independent and accountable acquisition organization (27-29).

Defence Procurement Policy Manual. (Australian Department of Defence, 1998). Intended as prime reference to program managers and purchasing officers, this manual contains procurement policy to satisfy statutory obligations and quality standards.

The Defence Procurement Policy Manual (DPPM) is divided in five sections, which embody twenty-nine chapters.

Section One - Procurement Framework - illustrates the legal setting for procurement activities in Australia. Following the Defence Reform Program (DRP), 14 Defence Programs were established:

- Defence Headquarters
- Navy
- Army
- Air Force
- Intelligence
- Support Command
- Joint Education and Training
- Defence Personnel Executive
- Defence Acquisition Organisation (DAO)
- Science and Technology
- Defence Estate
- Corporate Information
- Corporate Support
- Finance and Inspector General

The DAO Program manages the type of acquisition of interest in this research, which are Major Capital Equipment (MCE) projects. This is a decentralized framework for acquisition, which provides great decision making freedom to purchasing officers, at the same time that it makes them accountable for their decisions (Sec 1, 302-305).

Consultation mechanisms receive substantial stress in this section, encouraging participation of users and logisticians in the acquisition planning process (Sec 1, 308).

Section Two - Commonwealth Core Procurement Principles and Policies - presents and describes the:

- Core Purchasing Principles:
    - Open and Effective Competition,
    - Value for Money,
    - Ethics and Fair Dealing
- Core Government Policies:
    - Buying Australian,
    - Accountability of Purchasing Officers,
    - Supporting other Government Policies (Advancement of the interests of aboriginal, affirmative action, among others)

In order to encourage open and effective competition, specifications must be as simple as feasible; meanwhile, requirements should be presented using functional and performance wording instead of detailed design prescriptions (Sec 2, 121).

Application of the value for money purchasing principle implies the evaluation and comparison of significant life cycle benefits and costs corresponding to each purchase alternative. It becomes clear that, standing alone, purchase price is not a good parameter for evaluating an alternative value (Sec 2, 202-207). A checklist of value for money considerations is included in Annex C of the DPPM. A sample of those considerations, related to supportability issues, includes maintainability and durability, servicing and maintenance costs, present and future cost of spares, length of the supply chain and its vulnerability to disruption, transportation costs, and quality of after-sales facilities.

Aimed to improve accountability of purchasing officers, legislation has been passed to clarify statutory responsibilities for financial management, reduce the chain of command length, increase decentralization of management authority and responsibility, and improve Department of Defence control over financial and delegation policies (Sec 2, 502)

Section 3 - Key Requirements Affecting Procurement - explains how purchasing officers can help to reduce the industry tendering costs, how to manage financial issues, and how to apply the Value Management Incentive Program to the current project. Some of the measures that Defence has taken to reduce the tendering costs are (Sec 3, 104-105):

- Using commercial instead of military specifications and standards, as much as possible.
- Adopting commercial best practices.
- Encouraging long term supplier relationships and multi-phase procurements.
- Improving purchasing officers' knowledge and discernment.
- Preparing functional statements of requirements containing clear, complete, and not too detailed information.

Whole-of-life (WOL) costs, which is an equivalent concept to the better known LCC, is established as one of the elements in the evaluation of alternatives when the purchasing officer assess their value for money (Sec 3, 245-252).

Over and above encouraging performance and functional specifications, Defence abets contractors in preparing innovative solutions and in concentrating on results rather than on inputs and technical characteristics. The Value Management Incentive Program (VMIP) is a voluntary program that "encourages contractors to suggest methods for meeting Defence's functional requirements more economically, by allowing contractors to share the resultant savings with the Government" (Sec 3, 302).

Section 4 - Commonwealth Contracts - covers the Australian Contract Law, describes different types of contracts, and presents the standard terms and conditions of procurement tenders and contracts in Defence.

Section 5 - Conducting Procurement - provides guide to project managers all over the acquisition process. The general plan that depicts the decision process and accountabilities is the Project Management Acquisition Plan (PMAP).

After determining the existence of a need, the project manager must prepare a formal description of the requirement, which is the Statement of Requirement (SOR). It is stressed again here that in order to describe the required item or service promoting real competition, a SOR must be stated in functional and performance terms (Sec 5, 408). Additionally, several of the desirable features of a specification, according to the Department of Defence are (Sec 5, 412):

- To define the requirement clearly, briefly, and unequivocally.
- To provide enough information to estimate provision costs.
- To state the supplies' acceptance criteria.
- To discriminate between mandatory and desirable features (similar to the U.S. threshold and objective concepts).

- Not to over-specify requirements.
- To allow for innovative alternative solutions.

Commonwealth Procurement Guidelines: Core Policies and Principles. (Australian Department of Finance and Administration, 1998). The Minister for Finance and Administration issued this set of criteria to specify what is demanded during performance of procurement activities in the Government environment. Achieving a balance between prescription and empowerment for purchasing officers is a deliberate objective of this document. Hence, core policies and principles are provided to be applied and adapted, according to the circumstances of each type of acquisition (2).

The document states that the "fundamental objective of Commonwealth Procurement is to provide the means to efficiently and effectively deliver the Government's programs. " The core principles behind that objective are Value for Money, Open and Effective Competition, Ethics and Fair Dealing, Accountability and Reporting, National Competitiveness and Industry Development, and Support for Other Commonwealth Policies (2).

Value for Money is not considered an attribute, but the main basis of alternative comparison. Value for Money implies carefully contrasting costs, benefits, and options during the entire life of the offered system. Neither under-specify nor over-specify a requirement is one of the recommendations to achieve the best Value for Money.

Capital Equipment Procurement Manual - CEPMAN 1. (Australian Department of Defence, 1997a). This manual states the Department of Defence procurement policy for capital equipment. Taking precedence over every other document, CEPMAN constitutes the prime reference document for every officer involved in capital equipment acquisition, their associated systems, and their initial spares support (Part 1, 102-103). CEPMAN is organized in 4 parts and 82 chapters, whose titles are displayed in Appendix C.

Part 1 of the CEPMAN highlights the Defence Acquisition Organisation (DAO) Program - former Acquisition and Logistics (A&L) Program - role as the leading Defence acquisition authority. The DAO Program objective is (Part 1, 202):

> To realize the Government's priorities for the development of Australian defence capabilities through:
> - timely acquisition of capital equipment, facilities and systems that meet endorsed operational requirements, achieve value for money and are supportable,
> - provision of logistic policies, selected support and advice on asset management with an emphasis on efficiency and effectiveness and readiness and sustainability, with optimal use of the civilian infrastructure and commercial practice,
> - development of policies to enhance the capability of Australian Industry in support of defence self-reliance.

Detailed definitions of capital equipment and major capital equipment (MCE) are displayed in Chapter 3 of Part 1 (308-310). Materiel of interest for this research - new weapon systems and their major alterations - is included in the concept of MCE.

Figure 4 summarizes the two-phase acquisition process, while Table 10 displays the major elements of each stage. DAO plays the central role in the post-approval phase. During the pre-approval phase, DAO participation is confined to develop the Equipment Acquisition Strategy (EAS) and the Project Management Acquisition Plan (PMAP). Additionally, DAO contributes in the preparation of the equipment specifications and the Major Capability Submission (MCS) (Part 1, 301-307). When the equipment enters in operational service, DAO Program transfers management and support responsibilities to the pertinent Service Program (Part 1, 378).

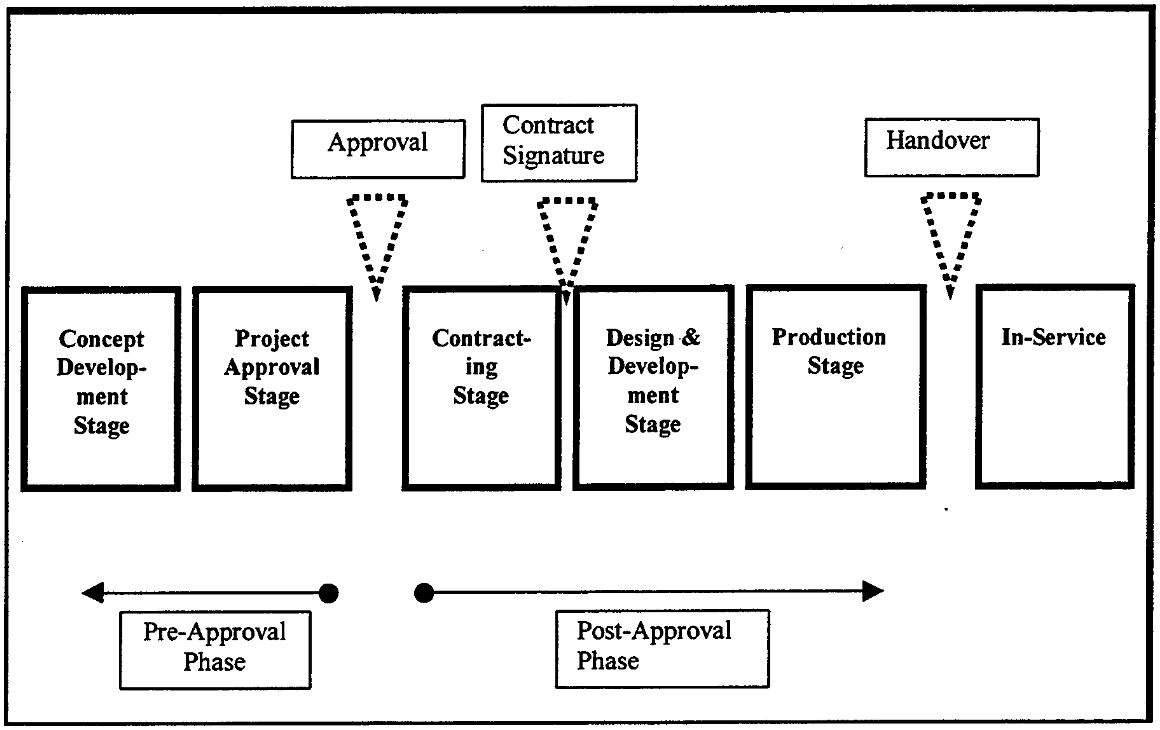


Figure 4. Australian Major Capital Equipment Acquisition Process

The MCS is comprised of two parts (Part 1, 339-341):

- Part 1, which is basically the updated Defence Force Capability Options Paper (DFCOP).

  Note: DFCOP is a document similar to the U.S. MNS (Bayley and Tabbagh, 1995: 119).

- Part 2, which incorporates resource implications to satisfy the need. Costs, supportability aspects, R&D implications, and timing are among the contents of this part.

The EAS provides the approach for acquiring and inserting the new system into the Services. It is developed concurrently to the MCS; however, the EAS provides a commercial perspective, detailing a procurement method, a schedule, responsibilities, and support considerations (Part 1, 345-346). Upon the EAS outlines, the project manager also formulates the Project Management and Acquisition Plan (PMAP), which is the project primary and most detailed internal planning document. The PMAP incorporates complete provisions for ILS (Part 1, 347).

Table 10. Major Elements of the Australian Major Capital Equipment Acquisition Program

PHASES	STAGES	MAJOR ELEMENTS
		-ADF Operational Concept (Conceived and prepared before starting the program)
Pre-Approval	Concept Development	-Defence Force Capability Proposal
	Project Approval	-Major Capability Submission -Equipment Acquisition Strategy -Project Management and Acquisition Plan (PMAP)
Post-Approval	Contracting	-Invitation to Register (*) -Request for Proposals (*) -Request for Tenders (including SOR) -Source Evaluation and Selection -Contract Development
	Design & Development	-Contract Management -Test and Evaluation Master Plan (TEMP)
	Production	-Transition Plan -Transfer Document -Project Completion Report

(*) Optional

During the pre-approval phase, the project manager also composes the Statement of Requirements (SOR), which is a set of "functional and performance requirements of the capability being procured" prepared upon the approved MCS. The SOR is to be part of the RFT (Part 1, 343-344).

Chapter 5 of Part 1 describes the project manager task in managing a MCE acquisition project. There are two prime objectives in that task (508):

- To ensure that the performance characteristics required in the MCS are realistic or achievable.
- To achieve the planned goals of performance, schedule, and cost in order to introduce the equipment into service successfully.

Among the list of project manager responsibilities, it is the need to conduct activities that permit the operation and support of the system when delivered to the user (Part 1, 510). To accomplish his duty, the project manager receives help from a team of specialists. Depending on the size and complexity of the project, the team members work full or part time for a particular project manager, using a line or matrix organization respectively. Despite its type of organization, the project team must have specialists in finance, engineering, quality assurance, configuration management, operational matters, Integrated Logistics Support, and contract coordination (Part 1, Ch. 5, Sec. 1, Annex A).

Chapter 12 of Part 1 describes the Project Management Education and Training (PMET) Program, which is available to DAO staff. A dedicated section in the Capital Equipment Program (CEP) Division manages the PMET matters using agreements with universities and professional bodies, in-house training, and supplying training and reference materials on-demand (1201-1204). Training is oriented to the currently used project management principles, techniques, and processes. A variety of training, from short courses to graduate university programs are offered, as well as participation in a discussion and information exchange forum, called Defense Project Management Network (1210-1218).

Chapter 1 of Part 2 describes defense policy for Australian industry. Recognizing that Australia cannot cost effectively produce all its defense materiel and support, policy makers have focused in carefully balancing indigenous versus overseas sources. Consequently, defense policy goals are to develop national sources of

> reliable supplies of consumable items during conflict, a capacity to repair and maintain equipment, including the ability to handle the additional maintenance requirements which would arise in conflict, and the capacity and appropriate technology to modify and adapt equipment to meet the demands of Australia's environment and strategic circumstances. In addition, major defence equipment will be produced in Australia when it offers value for money. (111)

Defence policy to influence local industry sustained development includes early consideration of locally provided through-life support, use of functional and performance specifications, and restraint in the application of military standards in favor of commercial standards (113 to 115).

Chapter 8 of Part 2 outlines defense policy about standardization. Being a valid method of achieving operational and logistical efficiencies, standardization is implemented applying an order of preference for standards, which is available in Annex A to Chapter 8 (807 and 823). On the other hand, the policy also recognizes that there are situations when standardization does not lead to significant performance, logistics, or production improvements, while premium costs rise. It is the project manager's task to survey these situations, trading off to achieve the operational requirements for the best value for money (825 and 828).

Chapter 14 of Part 2 outlines how Test and Evaluation (T&E) shall be planned and directed in support of capital equipment acquisition projects. After consultation with operational, maintenance, and technical authorities, the project manager must document any T&E demand in the Test and Evaluation Master Plan (TEMP). Preparation of the TEMP should be as early as possible, and its time and resource implications shall be included in the EAS and the PMAP (1417).

T&E categories encompass Operational (OT&E), Development (DT&E), Production Acceptance (PAT&E), Safety and Suitability for Service Evaluation (S3), and Aircraft Stores Clearance (ASCT&E). An important subgroup inside OT&E is called Operational Evaluation (OPEVAL). OPEVAL refers to T&E on production equipment that is supported by personnel and materiel as planned for normal operational use. Its goals are to:

- Prove compliance with Operational Effectiveness and Operational Suitability.
- Generate data for developing tactical features of the equipment.
- Verify the accuracy of documents covering the equipment operation.

Operational Effectiveness is defined as "the capability of the unit under test to perform its intended function under specified conditions over a given time period" (Annex A, 8).

Operational Suitability is "the capability of the system, when operated and maintained by operational personnel in the expected numbers and of the expected experience level, to be reliable, maintainable, operationally available, and logistically supportable in the specified environment within a specified time period" (Annex A, 8).

Including theoretical and field verifications of supportability, Logistics Support Analysis (LSA) is considered a permanent evaluation process all through T&E. Supportability must be an integral part of the system requirements and design, via the ILS elements. The US MIL-STD-1388-1A is the recognized source for the available options of tests and evaluations (Annex A, 10).

Part 3 is devoted to state policy and to provide direction on the financial aspects of project management. Chapter 5 explains how to estimate project costs and stresses how LCC differentiates from Capital Equipment Project Cost. The policy indicates that capital equipment project costs are "all one time costs necessary to bring the new equipment or system into operation," and the project manager is accountable for their estimation and management (501). These costs include funding provisions to cover the initial package of logistics support, typically enough for two to three years of operation (521-524). On the other hand, LCC are the "total costs of owning and operating the capital investment through its operational life," and are used to evaluate alternative system options during the acquisition cycle (526-528). Project managers are responsible for estimating costs and acquiring the initial support package, while the user service accounts for the follow on support (Annex D, 2-11).

Part 4 details policy and procedures to be applied during the acquisition process. Chapter 1 explains how an equipment acquisition strategy (EAS) is developed. The EAS "defines the project strategy for procurement and through-life support of capital equipment, which meets the capability requirement" (104). Chapter 2 advances on the PMAP preparation, approval, and contents.

Chapter 4 is dedicated to the Request for Tender (RFT) process. Policy establishes that "specifications must not be overly prescriptive and should be statements of performance and/or functional requirements" (410). Besides, when describing the tender evaluation criteria, policy includes ILS aspects and LCC among them (452). Annex B depicts the typical contents of a SOR, namely:

- Scope
- Applicable Documents and Technical definitions
- Project Management
- System Engineering
- Prime Equipment
- Integrated Logistics Support (including LSA, LCC, and the typical ILS elements)
- Configuration Management
- Quality Requirements
- Test and Trials
- Contract Requirements

Appendix 5 to Annex B shows details of the recommended structure of a Source Evaluation Report (SER). ILS aspects, manpower, training, ILS risk, LCC are among the areas to be evaluated when scrutinizing tenders and tenderers.

Chapter 9 outlines the handover of equipment and the closing of a MCE project. A Transition Plan, which is usually promulgated as part of the PMAP, must embody the handover arrangements. Despite its flexible format, a transition plan should content the following considerations, at least (909):

- Milestones for transition task fulfillment.
- Requirements of data and documents transfer.
- Arrangements to facilitate transfer, operation, and support of the equipment to the user.
- Arrangements for progressive acquisition and dissemination of support information.
- Establishment of an auditable transition trail and feedback procedures.
- Administrative arrangements for the project office closure.

At handover, a transfer document detailing the support status and designated responsibilities for ongoing tasks must be produced and signed by the project manager and the receiving authority (914-916). Among its features, this document contains the ILS certification of the system, which "is to provide the status of logistics support provisions for the equipment and should identify any unique or interim support arrangements put in place" (917).

Chapter 20 outlines the defense policy for Integrated Logistics Support for Capital Equipment. ILS is the concept adopted to warrant adequate logistics support and is defined as (2005),

> a disciplined approach to the management and technical activities necessary to:
> a) cause support considerations to influence requirements and design selection,
> b) define support requirements that are optimally related to the design and to each other,
> c) acquire the required support, and
> d) provide the required support during the operational phase at minimum cost.

The ILS elements recognized by the Australian defense policy are maintenance planning, supply support, manpower and personnel, training, technical data, facilities, PHS&T, support and test equipment, and computing support (2006-2015).

Due to its criticality in achieving and sustaining a military capability, ILS must receive equal attention in project management as design, finance, scheduling, and the other principal functions (2003), and must be addressed early in the acquisition cycle (2017).

The project manager is directly responsible for the "ILS planning, execution, review and audit" (2031). An ILS plan (ILSP) is the fundamental managerial instrument to determine, coordinate, and oversee the ILS goals, responsibility allocation, task scheduling, funding, and validation/verification of the achieved logistics support (2032).

Because the ILSP encompasses tasks from a number of different functional organizations, participation and previous agreement in the definition and scope of those tasks are crucial for a successful logistics support implementation. Hence, teamwork and empowerment play essential roles in the ILS management process (2033). Section 4 of Chapter 20 depicts who performs the logistics tasks in a project office. First, the project manager is the final liable officer for all the planning and managing matters, including ILS. When the project is complex enough, there is an ILS Manager (ILSM), who centralizes the logistics support activities. The ILSM usually chairs the ILS Management Team (ILSMT), which includes representatives from every organization with responsibilities in the system support provision. The ILSMT is a decision making group, whose members act and commit resources on behalf of their Division Heads. The ILSMT functions are to develop and review the ILSP, evaluate any LSA, provide solutions to arising problems, and review financial resource allocation for logistics support (2027-2028). ILS Task Working Groups reporting to the ILSMT may be created to accomplish circumscribed ILS tasks (2029). Finally, Logistic Element Managers (LEM) are designated as focal points from participating functional organizations to attend each project needs. LEMs are normally members of the ILSMT (2026).

Chapter 24 deals with the Cost/Schedule Control System Criteria (C/SCSC) that Defence expects to be followed by contractors in their internal management systems. Australian policy is virtually the same as the one applied by the US in this subject (2404-2405).

Proforma Request for Tender - DEFPUR 101. (Australian Department of Defence, 1996). Complementing CEPMAN 1, this manual contains terms and conditions to be used in tenders and contracts for major capital equipment acquisition. It is aimed to project managers and contracting officers. The vast majority of this document is presented in pro-forma fashion and it is organized in 28 chapters distributed in 4 parts, which are:

- Part One: Summary of Requirement,
- Part Two: Conditions of Tender,
- Part Three: Conditions of Contract, and
- Part Four: Statement of Work

Part One shows that the Summary of Requirement must include three parts:

- Background
- Scope of Request for Tender
- Guidance to Tenderers

Being the core of the requirement, the Scope of Request for Tender contains four chapters. One of those four chapters is Integrated Logistics Support (ILS). The list completes with Supplies Required, Projected Schedule of Events, and Australian Industry Involvement (Part 1, 2).

Annex A to the Part Two provides guidance on the preparation of industry responses to the Request for Tender (RFT). According to DEFPUR 101 prospective contractors shall render tenders in 11 separate volumes, which are Executive Summary, Tenderer Profile, General Contract Matters, Financial Matters, Technical and Operational Description, Proposed Australian Industry Involvement, Project Management, Engineering Management, Logistics Support, Quality Control and Assurance, and Statement of Compliance. The Volume 9 - Logistics Support - must include "clear, succinct and explicit" ILS information that satisfies the requirement (1-2).

Annex B to the Part Two contains a number of Tender Deliverable Requirements (TDR), which help prospective contractors to provide information following a common structure. TDR 032 purpose is "to elicit details from tenderers in relation to [their] Cost Schedule Control System Criteria (CSCSC). " If the firm uses a Cost Schedule Control System, a declaration of compliance must be enclosed (85-88).

Part Four - Statement of Work - includes the titles of subjects that an SOW might contain. They are:

- Scope
- Applicable Documents and Technical Definitions
- Project Management
- System Engineering

- Prime Equipment
- Integrated Logistics Support
- Configuration Management
- Quality Requirements
- Test and Trials
- Contract Data Requirements

The ILS chapter includes as its subtitles Plan; Logistics Support Analysis (LSA); LCC Analysis; Maintenance Support; Supply Support; Manpower and Personnel; Training; Data; Support and Test Equipment; Facilities; Packaging, Handling, Storage, and Transportation; Software Support; Post-Acceptance Support; and Introduction into Service (Part 4, 2-3).

Developments and Current Issues in the Major Capital Equipment Program. (McPherson, 1998). This is a speech given to the 1997 Defence Procurement Seminar by Mrs. Merrilyn McPherson, First Assistant Secretary Capital Equipment Program that summarizes DAO achievements in the Defence Reform Program.

Appendix D presents a simplified organizational structure of the DAO. This new organizational chart groups similar projects in Technology Branches, combines compatible Technology Branches into functional System Acquisition Divisions, and clusters System Acquisition Divisions and the Capital Equipment Program under the Deputy Secretary Acquisition authority.

The speech also refers to the committees involved in the MCE acquisition process. Table 11 contains a summary of the most important committees, their members, and functions.

The increasing application of Integrated Product Teams with empowered representatives of a variety of functional specialties is also mentioned in the document.

Table 11. Principal Defence Committees intervening in the MCE Acquisition Process

COMMITTEE	MEMBERS	FUNCTIONS
Defence Capability Committee (DCC)	-Deputy Secretary Strategy & Intelligence (DEPSEC S&I) (*) -Vice Chief of the Defence Force (VCDF) - Deputy Secretary Acquisition (DEPSEC A)	-Making decisions on capability development priorities. -Recommending the annual program of investment.
Capability Forum	-Head Capability Program and Resource Planning (*) -Head Capability Development -First Assistant Secretary, Capital Equipment Program (FASCEP)	-Making capability decisions on issues delegated by the DCC. Recommending level of investment for less complex capabilities.
Defence Source Selection Board (DSSB)	-FASCEP (*) -Members of DAO according to project type and complexity.	-Endorsing EAS -Recommending the preferred source of supply. -Providing guidance on contract negotiation issues.
Defence Acquisition Review Board (DARB)	-DEPSEC A (*) -FASCEP -Head Industry & Procurement Infrastructure -Head Systems Acquisition, Electronics. -Head Systems Acquisition, Maritime & Ground. -Head Systems Acquisition, Aerospace	-Monitor complex project performance. -Monitor MCE Program as a whole.

(*) Denotes Chairman

<u>The Assurance of R&M in Acquisition Programs of the Royal Australian Air Force (RAAF).</u> (Bayley and Tabbagh, 1995). Included in the 1995 Proceedings of the Annual Reliability and Maintainability Symposium, this article describes how the RAAF assures system Reliability and Maintainability (R&M) throughout the acquisition process.

The effort for measuring R&M originates in recognizing them as crucial determinants for operational availability and for LCC.

This paper relates how R&M requirements are developed, quantified, requested to prospective contractors, controlled, and tested and verified. Assurance of R&M is described along the whole acquisition process, stressing:

- Inclusion of quantitative R&M requirements since the RFT development.
- Freedom conceded to tenderers in their proposals to achieve R&M requirements.
- R&M modeling effort to monitor R&M progress and to facilitate early tradeoffs among performance, cost, and schedule.
- Formal R&M demonstration before acceptance into service.

The role of the RAAF's Centre of Expertise (COE) for Reliability and Maintainability as a provider of policy, procedures, and technical advice is also emphasized.

Spain

Spanish Air Force's Program Planning, Programming, and Control Directive - Directive 20/93. (Spanish Air Force, 1993). This is the primary Spanish Air Force's (SAF) guide for planning, developing, and controlling the process of weapon system acquisition. It is known as Directive 20/93.

Directive 20/93 expressly recognizes NATO's Phase Armaments Programming System (PAPS) as its framework. Consequently, most of its provisions closely reflect the PAPS stipulations (1). Particularly, Directive 20/93 considers the first four phases in detail, but only prescribes some oversight actions covering the last four phases of PAPS. Appendix E shows the phases and milestones of the PAPS, which coincide with the ones in the SAF Directive. This set of phases and milestones can be tailored to every specific program.

Milestone 1 consists of the Mission Need Document (MND) submission, by the user organization. Every operational or logistical deficiency not solvable using a unit own resources shall derive a MND (3).

During Phase 1, deficiencies are studied, validated, and transformed in a set of functional requirements and technical, economic and programmatic estimations. This work is performed by an Evaluation Group comprised of representatives of all the divisions of the Air Staff and a user delegate. During this evaluation work, introductory logistics, technical, operational, financial, risk, and schedule related issues are considered (5). To facilitate understanding, Appendix F displays the Air Staff organizational chart.

Milestone 2 characterizes the end of phase 1. This milestone is portrayed by the Outline Staff Target Document, which is prepared by a Working Group consisting of personnel from the Air Staff, the Logistics Support Command (MALOG), the Personnel Command (MAPER), and the user. The same considerations mentioned for phase 1 are now further heeded, distinguishing between objectives and thresholds. The directive advises to appoint a Program Manager at this time, and prescribes that the milestone authority is always embodied by the SAF Chief of Staff (6).

Finishing at milestone 3, Phase 2 or Pre-feasibility includes the analysis of alternatives and the selection of the most suitable ones. The analysis must encompass logistics factors and is performed by the working group and the program manager. The presentation for the Chief of Staff approval of the Staff Target Document represents milestone 3. If the program manager was not commissioned yet, commissioning must be done at this time (8-9).

During Phase 3 or Feasibility, the selection of the best alternative and a detailed definition of technical, operational, and logistics requirements is performed, along with economic feasibility considerations that contemplate LCC. This work is accomplished by the working group and the program manager, as well as by groups of specialists in the operational, technical, logistical and administrative fields. The conclusions of this work generate the Staff Requirement Document, which presentation configures milestone 4. If it was not done before, the Program Office must be constituted now. After the Staff Requirement Document is approved by the Chief of Staff, the working group is disbanded.

After milestone 4, the program manager and its program office must direct, coordinate, and control the day-to-day development of the program and the participation of every organization involved in it. The program manager reports organically to the organization in charge of the management of a particular program (9-12), which is usually the Systems Directorate of the MALOG for weapon system acquisitions. Besides, the program manager reports functionally to a Steering Committee.

The Steering Committee is chaired by the Deputy Chief of Staff and includes a number of general officers from the MAPER and MALOG Directorates, every Air Staff Division, the user's command staff, and the Financial Affairs Directorate. The program manager also integrates the committee. This committee must overview the program development and must provide advice to the Chief of Staff about significant program related decisions (14-15).

The program manager and his office work as coordinators and focal points of the efforts of many organizations to advance the program. Among program manager's tasks, integrated logistics support is clearly identified as one of his primary concerns. The program office must have personnel covering at least the following areas:

- Operations
- Engineering
- Integrated Logistics Support, recognizing maintenance, personnel, training, supply, facilities, ground support equipment, technical data, computer support, and PHS&T as its elements.
- Contracting and Legal Affairs
- Financial Affairs

The Directive 20/93 also describes aspects of intermediate term planning in the SAF and classifies the programs according to interest, complexity, and investment. All the programs that are subject of this research are included in category A.

NATO's Handbook on the Phase Armaments Programming System (PAPS) - AAP 20. (NATO International Staff, 1989). This document is included in the Spanish case because SAF's doctrine explicitly accepts it as the framework for weapon system acquisitions (Spanish Air Force, 1993: 1).

The handbook is organized in two volumes. Volume I describes the PAPS process, provides implementation guidelines, furnishes pro-forma milestone documentation, and illustrates about PAPS terminology. Volume II depicts a set of

PAPS related activities and management issues as reference material for the Conference of National Armaments Directors (CNAD). Volume I contains three chapters and volume II includes five.

PAPS' main objective is "to provide a systematic and coherent, yet flexible, framework for promoting co-operative programs on the basis of harmonized military requirements" (2). PAPS is intended as an adaptable tool to be used by nations in a systematic development of multinational and/or national programs. PAPS divide the system life cycle in segments called phases, each one preceded by a milestone, where decision among alternatives must be made. Each milestone represents a point in the weapon system life cycle, "where past work is validated and future work agreed" (5). Appendix E presents an overview of the PAPS.

Phases 1 to 4 aim to choose the best solution for an established operational and/or logistical necessity. Phases 5 to 7 are oriented to develop the selected solution so that it can be executed. Phase 8 embodies the weapon system disposal (7).

Chapter III contains four appendixes. Appendix A describes some milestone procedures. Appendix B provides PAPS implementation guidelines and Appendix C presents milestone document formats. Finally, Appendix D is a glossary of terms and concepts. A remarkable feature is the early manifestation of logistics support requirements. They appear at Milestone 1 and are continuously improved until the end of Phase 4 or Project Definition, when the NATO Design and Development Objective is issued. After that, the effort in the supportability arena is focused in designing, producing, and testing a product that fulfills the requirements (15-21).

Volume II describes the CNAD policy for cooperative programs in chapter II, after an introductory chapter I. Chapter III presents a set of administrative procedures for developing Mission Need Documents (MND) by NATO Military Authorities (NMA).

Chapter IV groups some program management considerations in two sections. Section A describes sets of typical tasks and activities at every one of the eight phases. Similarly, Section B provides sets of logistics and training activities along all the phases of the PAPS. All these tasks are offered in terms of suggested actions that program managers might use during their particular program developments (54).

Finally, Chapter V presents an overview of the NATO standardization process. The three main groups of standards - operational, materiel, and administrative - are described briefly; although materiel standardization receives more detailed consideration.

Portugal

Data from this country was collected largely from a personal interview; outcomes are shown in Chapter IV.

IV. Analysis

Introduction

This chapter is divided in two segments. In the first segment, an analysis of the gathered information is performed in a separate section for each country. Every country case study is guided by the set of investigative questions presented in Chapter I. After analyzing each country individually, the second segment of the chapter summarizes the findings in a set of tables, where similarities, tendencies, and circumstances are easier to discover. This integrative summary constitutes the basis for synthesizing a set of guidelines for improving the Argentine Air Force's acquisition logistics process, which is the nucleus of chapter V.

The United States case opens the discussion, followed by Australia, Spain, and Portugal.

United States Case

Which Support Elements are Addressed in Every Acquisition Process? DoD 5000.2-R stresses the idea that "supportability factors are integral elements of program performance specifications." At the same time, it introduces the concept that "support requirements are not to be stated as distinct logistics elements, but instead as performance requirements that relate to a system operational effectiveness, operational suitability, and life-cycle cost reduction" (Part 2, 6).

Despite the exigency of integrating the logistics elements in terms of program performance specifications, the support elements still constitute the foundations of acquisition logistics. Support elements integrate a checklist of subjects that the logistician and the program manager must not forget when assessing supportability of the new system (Defense System Management College, 1997a: 7-1 to 7-2).

Admitting unessential differences, several sources recognize a group of traditional support or logistics elements (Defense System Management College, 1997a: Ch 7, 1; Jones, 1987: 2; Fabrycky and Blanchard, 1991:112; Blanchard and others, 1995: 12-13; Blanchard, 1992: 11-13). For this research purpose, the support element presentation made by the Acquisition Logistics Guide will be followed, namely:

- Maintenance Planning
- Manpower and Personnel
- Supply Support
- Support and Test Equipment
- Training and Training Support
- Technical data
- Facilities
- Packaging, Handling, Storage, and Transportation
- Computer Resources Support
- Design Interface

How are Supportability Requirements Stated in Order to Translate Them into Cost Effective Programs? As it was just exposed, it is mandatory to term support requirements in a performance requirement fashion (Department of Defense, 1996b: Part

2, 6). Accordingly to this exigency, the MIL-HDBK-502 appoints that the requirement must be measurable to avoid any subjectivity. Additionally, the requirement must establish what is needed, and not how the design should achieve the desired outcome, avoiding driving out any innovative approach (Ch 6, 5 and 13). These requirement features imply that traditional military specifications defining particular design solutions should no longer be used in contracts and solicitations, except by especial waiver from the MDA (Department of Defense, 1996a: 5).

As well, DoD 5000.1 establishes that not only program performance, but also cost and schedule must be termed in two different levels: thresholds and objectives (5). DoD 5000.2-R defines threshold as "the minimum acceptable [performance] value that, in the user's judgement, is necessary to satisfy the need"; and objective as the performance value "desired by the user and which the PM is attempting to obtain" (Part 2, 3). The gap between threshold and objective is the PM maneuvering space for trading-off among performance, cost, and schedule.

There is a clear intention to intertwine supportability and operational requirements since the first Operational Requirements Document and its subsequent updates at every phase starting point.

Simplicity is a paramount objective, because simpler the requirement is; more cost effective the program should be. Emphasis is applied in reducing the number of Key Performance Parameters, which are those "so significant that failure to meet the threshold can be cause for the concept or system selection to be reevaluated or the program to be reassessed or terminated" (Defense Systems Management College, 1998: Ch. 5, 3). The U.S. Air Force with its new Statement of Work (SOW) and Statement of Objectives

(SOO) took a further step in that direction. Contrary to the old-fashioned very long and detailed SOW, the trend is to append an SOO to the Request for Proposal (RFP) sent to the prospective offerors. While both, the SOO and the SOW, are termed in performance premises, the SOO is a very short document addressing exclusively product-oriented goals. The typical four-page-SOO establishes only the top-level and crucial ends of an acquisition program, and leaves to the offerors the greatest freedom in designing the way of achieving those objectives. The offerors develop the SOW and submit it later to the program office, for analysis and acceptance (Department of Defense, 1997: Ch. 8, 8-9).

How Are Acquisition Teams Constituted to Take Charge of Acquisition Logistics Issues? One of the major themes of the DoD 5000 Series' 1996 update was oriented to "maximize overall performance, not just the performance of individual areas" using cross-functional teams intensively (Department of Defense, 1996c: 2). The implementation of Integrated Product and Process Development (IPPD) techniques using Integrated Product Teams (IPT) is central to the newly designed acquisition process. IPTs are constituted by representatives of every organization with interests in the program, without exclusion of those who could arise objections. Each participant must be empowered to the maximum reasonable level to make commitments on behalf of his or her functional area. Some general rules applicable to the IPTs functioning are (Department of Defense, 1996b: Part 1, 7):

1. Open discussions with no secrets.
2. Qualified, empowered team members.
3. Consistent, success-oriented, proactive participation.
4. Continuous up-the-line communications.
5. Reasoned disagreement.
6. Issues raised and resolved early.

There are three levels of IPTs, which are Overarching IPT, Working-level IPT, and Program IPT in decreasing order of oversight scope. Logisticians are part of all three levels of IPTs. No matter at what level, they must contribute their point of view to the group from the very beginning of the program, influencing not only the design of the support, but also the design of the system itself. Especially important is participation at high level IPTs where logisticians are probably not focused on supportability issues, but they must identify and manage the logistical consequences of the different alternatives under scrutiny and influence the general heading of the program (Department of Defense, 1997: 9-1 to 9-8).

Working in this teamwork environment presents serious challenge to group leaders and group members, which can be overridden only on basis of personal skills and training. Team members not only must be proficient in their own fields, but also they must understand and practice teamwork techniques. Group leaders must evolve from the traditional supervisory style to team leader style, and excel in subjects like "group process skills, leadership empowerment, flexibility, conflict resolution, stakeholder relationships, resource allocation, and communications coordination" (Defense System Management College, 1998: 4-6 to 4-7).

Understanding that the increasingly complex acquisition world requires a well-prepared workforce, the United States Congress passed the Defense Acquisition Workforce Improvement Act (DAWIA) in 1990. This Act instructs the Secretary of Defense to "establish policies and procedures for the effective management (including accession, education, training, and career development) of persons serving in acquisition positions in the Department of Defense" (Ch 1, Sec 1701 a). At the DoD and the

Services levels, this law triggered a series of actions to designate regular and critical acquisition positions, constitute the Acquisition Corps, implement certification procedures for contracting and PM positions, create the Defense Acquisition University, and establish acquisition career paths and requisites (Department of the Air Force, 1994: 5-17). There is a big effort pushing to achieve a professional acquisition workforce, which is the seed for nurturing acquisition teams.

How Are Acquisition Teams Organized in the Decision-Making Chain?

Being the nucleus of the acquisition program, the PM position embodies the entire program status in the decision making chain.

As Figure 3 shows, PM chain of command has two levels of oversight between his position and the Milestone Decision Authority (MDA). The MDA for Major Defense Acquisition Programs (MDAPs) is the Defense Acquisition Executive, embodied in the Under Secretary of Defense for Acquisition and Technology (USD A&T). This person establishes acquisition policies and procedures for acquisition programs, and is the main acquisition official in the DoD. The second echelon is the Component Acquisition Executive (CAE), who is the related Assistant Secretary in each of the services. Finally, the last tier above the PM is the Program Executive Officer (PEO), who is a high rank military or civilian official in charge of a group of similar major programs. A number of collegiate organizations accomplish an important function as advisors of the different levels in the chain of command, and making decisions that are not exclusively reserved to the executive officer. The Defense Acquisition Board (DAB) is the senior-level advisory group for the USD (A&T). An Overarching IPT (OIPT) furnishes strategic guidance to the program and provides counsel to the CAE, PEO, and DAB about the program progress. Finally, the Working-Level IPTs and an Integrating IPT (IIPT) help the PM to manage the acquisition program in their specific areas of influence (Department of Defense, 1996b: Part 5; Defense System Management College, 1996: 6-14).

The goal is to streamline the chain of command as much as possible to increase the PM decision capability; and, as stated in DoD 5000.2-R, " to resolve as many issues and concerns at the lowest level possible, and to expeditiously escalate issues that need resolution at a higher level, bringing only the highest level issues to the MDA for decision" (Part 5, 3).

Other distinctive characteristic of the Program Management conception in the U.S. is that the Program Manager Office remains in charge of the system throughout its whole life cycle. There is only one focal point of responsibility and authority for development, production, deployment, alterations, and disposal of the system. Long term oriented and performance/supportability balanced decisions are favored by this concept (Defense Systems Management College, 1996: Ch. 9, 1-2).

How Are Logistics and Supportability Considerations Integrated into the System Engineering Process that Frames a Weapon System Acquisition? Being an interdisciplinary approach to develop and validate a total system design of products and processes that fulfill the user requirements along program's whole life-cycle, systems engineering applies to product hardware, software, and logistics resources combined in a balanced formula (Department of Defense, 1997: 4-12 to 4-18). The iterative process of systems engineering is depicted in Figure 2, and is recurrently applied in all the phases of the acquisition life cycle displayed in Figure 1.

The purpose of acquisition logistics in the systems engineering process is to influence the design solutions from a logistics standpoint, and to define the optimal set of logistic resources, via analysis of those system design characteristics which demand operational support. Performing acquisition logistics management as part of the systems engineering process is a PM mandatory activity since the program initiation and during the whole program development. "Supportability analyses shall form the basis for related design requirements included in the system specification and for subsequent decisions concerning how to most cost-effectively support the system over its entire life-cycle" (Department of Defense, 1996b: Part 4, 4).

Usually, performance objectives sustained by engineering people antagonize with logistics objectives during system design and development. This inevitable conflict can be minimized if both engineers and logisticians apply collaborative effort in satisfying the user requirements without hurting each other's performance. Success in this task requires cooperation, mutual understanding, and commitment to a balanced outcome from the very beginning of the acquisition life cycle, when things change quickly, design is not frozen, and alterations do not represent any serious waste of time and money.

Systems engineering provide the organized framework to embed supportability factors in the system design through adequate engineering/logistics tradeoffs. The objectives of poised supportability integration in the system engineering process are (Defense Systems Management College, 1997a: Ch. 8, 1-2):

- to produce readiness objectives that will be challenging but attainable,
- to identify realistic reliability and maintainability requirements to achieve these objectives,
- to identify support and manpower drivers, and

- to assign appropriate priority to logistics element requirements in system design tradeoffs.

Coincidence arises when stressing the benefits of early consideration of logistics issues in the system design, especially for optimizing the system cost of ownership. Langford presents data based on experience with Department of Defense systems that demonstrates two important phenomena (263-266):

- Life-cycle costs are comprised approximately by system research and development of 10% of the total; production another 30 % of the total; and operations and support the remaining 60%.
- Decisions made before the end of the conceptual definition of the system determine near 70% of total life-cycle costs. If the same analysis is performed when production starts, almost 95% of the total cost of ownership is already committed.

Other sources present similar figures (Blanchard, 1992: 72; Fabrycky & Blanchard, 1991: 13; Followel, 1995: 402; Gansler, 1989: 157-158).

Even though supportability considerations take especial relevance in the system engineering process at the early phases of the acquisition life cycle, fast technology turnover provides a reason to continue including supportability in the decisions made along the operational portion of a system life. Therefore, systems engineering approach is applied to monitor technological obsolescence and probable sources of supply scarcity after the system is fielded, in order to detect divergence between the user needs and system total performance.

Summarizing, supportability aspects must be an integral part of the systems engineering approach at every phase of the life cycle, as a practice that incorporates logistics previsions in the design core to achieve cost-effective systems.

<u>How Is Supportability Measured and Demonstrated in the Acquisition Process?</u> According to the MIL-HDBK-502 supportability is " the capability of a total system design [hardware, software, and support system] to support operations and readiness needs throughout the system's service life at an affordable cost" (Sec 4, 14). Then, a certain degree of supportability is achieved by means of a set of system design characteristics and some planned logistics resources, always constrained by the total cost incurred. Consequently, it makes sense to assess supportability at the total system level using parameters like operational availability and life cycle cost, or equivalently, equipment readiness and affordability. The next investigative question in this research will explore costs and their implications. Consequently, without forgetting affordability, emphasis is going to be applied now in the readiness side of the supportability measurement and demonstration.

Availability is the parameter used to represent the system readiness. However, although availability is generally defined as (Ebeling, 1997: 254)

$$Availability = \frac{Up\ Time}{Up\ Time + Down\ Time} \tag{1}$$

there are other three more specific definitions that better define under which conditions availability is evaluated. They are (Defense Systems Management College, 1997a: 10-3 to 10-4):

$$Operational\ Availability = Ao = \frac{MTBM}{MTBM + MMT + MLDT} \quad (2)$$

$$Inherent\ Availability = Ai = \frac{MTBF}{MTBF + MTTR} \quad (3)$$

$$Achieved\ Availability = Aa = \frac{OT}{OT + TCM + TPM} \quad (4)$$

Where

MTBM = Mean Time Between Maintenance

MMT = Mean Maintenance Time (corrective and preventive)

MLDT = Mean Logistics Down Time

MTBF = Mean Time Between Failure

MTTR = Mean Time To Repair

OT = Operating Time

TCM = Corrective Maintenance Time

TPM = Preventive Maintenance Time

When referring to availability, the user is usually addressing operational availability because all the operating environment factors are included in the operational availability definition. However, operational availability is not suited to be included in acquisition contract, because habitually contractors do not exercise control of the operational supporting structure. Inherent and achieved availability are easier to measure and more system hardware-oriented. Because of that, they are the preferred contracting parameters in spite of their weakness in representing real field conditions (Defense Systems Management College, 1997a: 10-2 to 10-4). Being currently a subject of research, the translation process from user operational needs to contractual specifications terms and vice versa is complex, lacks of an standard methodology, and usually presents deficiencies (Born and Criscimanga, 1995: 107). It is a program office responsibility to perform this translation as effectively as possible. The literature provides a set of models to perform this translation between operational and design parameters (Rome Laboratory, 1995: 349-353).

Contracting parameters must be specific, measurable, and testable. Likewise, operational availability is built over three basic pillars: reliability, maintainability, and the support system effectiveness. Consequently, measurements of readiness must be defined in terms of concrete reliability and maintainability parameters. Similarly, affordability or ownership costs goals shall be termed in the same way. The Acquisition Logistics Guide offers a sample of user measurements translated to reliability and maintainability contractual specifications that is quoted as Table 12:

Table 12. Comparison of Sample User Requirements Translated to Contractual Specifications (Defense Systems Management College, 1997a: Ch 10, 6)

OBJECTIVE AREA (User)	RELIABILITY	MAINTAINABILITY
Operational Effectiveness		
Increase Readiness	Mean Time Between Downing Events	Mean Time to Restore System
Increase Mission Success	Mean Time Between Critical Failures	Mean Time to Restore Functions
Ownership Costs		
Decrease Maintenance Personnel Costs	Mean Time Between Maintenance Actions	Mean Labor Hours per Maintenance Actions
Decrease Logistics Support Costs	Mean Time Between Removals	Parts Costs per Removal

Once defined for the entire system, reliability and maintainability parameters need to be allocated downwardly to subsystems, LRUs, SRUs, and components. This is part of the functional analysis/allocation activity of the systems engineering approach, and is crucial to design the system. Methods for this allocation are out of the scope of this research and available from literature (Ebeling, 1997: 151-157).

Measurable supportability parameters must be tested along the whole acquisition cycle in order (Defense Systems management College, 1997a: Ch 11, 2):

- to provide assurance of system supportability under anticipated wartime conditions;
- to verify that the logistics support planned and developed for the system is capable of achieving established system readiness levels within the established life-cycle cost thresholds; and
- to demonstrate that system readiness objectives are attained at peacetime utilization rates.

Logistics tests and evaluations are performed at DT&E, OT&E, and pre and post-deployment supportability assessments. The logistic manager (LM) must participate in the planning of these T&E activities as a member of the T&EIPT, and has primary responsibility in the post-deployment supportability assessments. Appendix G presents the logistics objectives of the Test and Evaluation (T&E) Program, throughout the acquisition life cycle. It is important to recognize that all the logistics elements must be subject of individual evaluation to establish their influence on system readiness and life-cycle costs.

T&E planning must start in phase 0 and, if feasible, should combine developmental and operational tests to avoid wasting time and financial resources (Department of Defense, 1996b: Part 3, 15-16).

How Is the Increasing Concern about Costs Influencing the Necessary Tradeoffs among Performance, Schedule, and Costs? One of the three principal objectives of acquisition logistics is "to ensure that the system can be cost effectively supported through its life-cycle" (Department of Defense, 1997: Sec 4,1). Affordability is one of the two goals of every RAM program (Defense Systems Management College, 1997a: Ch 10, 6). Compared to its other two partners of every program, performance and schedule, costs have been increasing their relative importance to achieve a tripartite equilibrium.

This rising pressure to control costs motivated Dr. Paul Kaminski - former USD (A&T) - to introduce the concept of cost as an independent variable (Department of Defense, 1995: 1). Under CAIV optics, the user, trimming any not essential requirement must early face cost/performance trade decisions. Realistic and aggressive cost goals must be established at the beginning of the program. At the same time, performance and schedule goals are to be defined and prudent risk taking encouraged to achieve a balanced outcome of cost, performance, and schedule. The old concept of viewing cost as a constraint acting only after achieving performance and schedule goals is gone. Nowadays, cost, performance and schedule are evenly important at the Analysis and Control step of the iterative system engineering process, where tradeoffs among them take place.

Motivation of contractors and DoD personnel to attain breakthroughs in this area plays an important role. Some of the mechanisms used are competition, profit, integrated product teams, source selection criteria, exigent cost goals, and improved cost-performance tradeoff processes that empower PM and contractors (Department of Defense, 1995: 6).

If costs have to be under control, efficient cost monitoring should be exercised. The Government has issued a cost/schedule control systems criteria (C/SCSC) to be met by every contractor's internal control system in order to assure its validity and accuracy (Department of Defense, 1996b: Part 3, 9 and Appendix VI). These criteria allow making decisions upon reliable basis without requiring the use of any specific internal management control system.

Life-cycle costs must be evaluated permanently during the acquisition life cycle, but especially at each milestone. Moreover, DoD 5000.2-R establishes that every major program can not enter into Phase 2 if not only an internal appraisal of LCC, but also an independent estimation are presented to the MDA (Part 3, 21). An updated LCC estimation provides crucial information to the program manager. For example, inputs on competing system alternatives, resource requirement determination, cost driver identification, figures of merit for tradeoff analyses, and basis for cost control and management (Defense Systems Management College, 1997a: Ch 13, 3). Additionally, continuous cost assessments are necessary because not only costs change over time, but also economic conditions do. Under different economic conditions, affording the same LCC could be impossible.

The user and the acquirer must accept lesser but acceptable performance to keep costs inside the trade range. The inclusion of CAIV and LCC concepts in the acquisition strategy (Defense Systems Management College, 1998: Ch. 2, 11), and the creation of a Cost/Performance IPT (CPIPT) are necessary steps toward that goal. Including program people, users, and sometimes contractors, this IPT should enact the program cost objectives and provide a natural environment to make trade off decisions. Finally, as other indicator of these subjects importance, there is a Cost Analysis Improvement Group (CAIG) working at the OSD level, which encourages the application of CAIV, supervises the cost analysis process, and advises the MDA about cost objectives compliance.

Australian Case

Which Support Elements are Addressed in Every Acquisition Process?

Representing the prime reference for MCE acquisition, CEPMAN 1 recognizes nine basic ILS support elements, namely (Australian Department of Defence, 1997a: Part 4, 2006-2015):

- Maintenance Planning
- Supply Support
- Manpower and Personnel
- Training
- Technical Data
- Facilities
- Packaging, Handling, Storage, and Transport
- Support and Test Equipment
- Computing Support

These support elements are behind every consideration of supportability, from the tendering process (Australian Department of Defence, 1997a: Part 4, Ch 4, Sec 6, Annex B) to the acceptance into service and after (Bayley and Tabbagh, 1995: 123).

How are Supportability Requirements Stated in Order to Translate Them into Cost Effective Programs? Even before the project is approved and when the broadest characteristics of the new capability are being developed, supportability requirements are already part of the project core definition, along with operational requirements, and cost/schedule estimations (McPherson, 1998: 3). Later in the acquisition process, the project manager articulates an Equipment Acquisition Strategy (EAS) and a Program Manager Acquisition Plan (PMAP), where supportability requirements evolve and improve in completeness and detail. It is upon the EAS and the PMAP that the Request for Tender (RFT) process begins. At this point, Defence managers' focus shifts from capability oriented to commercial oriented, and they produce the Statement of Requirements (SOR) (Australian Department of Defence, 1997a: Part 1, 345). The SOR "describes the functional and performance requirements of the capability being procured" and is an essential part of the RFT (Australian Department of Defence, 1997a: Part 1, 343). The SOR represents the translation of a Service need into a set of functional and/or performance termed requirements, which are to be understandable and achievable for the contractors. The way of terming the SOR is aimed to encourage efficient and innovative offeror approaches, via establishing objectives but not limiting the methods of achieving them. ILS requirements constitute one of the main chapters of the SOR.

Helping project managers in the preparation of specifications, policy provides a number of prescriptions. Namely (Australian Department of Defence, 1997a: Part 4, 1209; Australian Department of Defence, 1998: Sec. 5, 408-414):

- Avoiding physical or design description, and prioritizing operational and performance parameters.
- Ensuring to cover structural integrity, performance, reliability, supportability, maintainability, and safety aspects of the requirement, as cost effectively as possible.
- Avoiding over specify the requirement.
- Describing how each requirement will be considered met, at the acceptance test stage.

Bearing in mind that one of the objectives of the Acquisition Program is to enhance Australian Industry capability (Australian Department of Defence, 1997a: Part 1, 202), there is considerable Government commitment to facilitate access to Defence biding for the local industry. Defence recommends using commercial standards for phrasing supportability requirements, limiting the use of military standards to exceptionally justified situations (Australian Department of Defence, 1997a: Part 2, 115). Specifications must "not contain features that directly or indirectly discriminate against Australian or New Zealand suppliers" (Australian Department of Defence, 1998: Sec 5, 412). Additionally, Defence must inform tenderers about which standard applications are to be considered mandatory, and which allow some negotiation margin (Australian Department of Defence, 1997a: 825). Standardization is considered frequently desirable; however, if it generates significant price increments, a careful analysis of convenience must be performed (Australian Department of Defence, 1997a: 828).

How Are Acquisition Teams Constituted To Take Charge of Acquisition Logistics Issues? The Australian Defence Acquisition Organisation (DAO) embraces the use of Integrated Project Teams for managing acquisition projects. Integrated Project Teams conveys the idea of merging "staff with skills in the various project management disciplines, including engineering, logistics, contracting, business, industry, and finance" (McPherson, 1998: 3).

For large and complex projects, the staff is full-time assigned to the projects; conversely, for small projects the competent practitioners are provided part-time by policy and support divisions under the DAO structure (Australian Department of Defence, 1997: Part 1, 504-505).

Chaired by the ILS Manager, the ILSMT is the core acquisition logistics team. When forming the ILSMT, the project manager must be extremely careful to include representatives from each one of the organizations involved in the logistics support of the new system. Those representatives are expected to make decisions and commit resources on behalf of their organizations, giving to ILSMT its executive character. This team conception is equivalent to the U.S. IPT notion. Additionally, several ILS Task Working Groups (ILSTWG) may be created to attend specific areas of work. They report to the ILSMT (Australian Department of Defence, 1997: Part 4, 2027-2030).

Previous concern about the training and education level of the acquisition people was increased by the conclusions of the Defence Efficiency Review (DER), which advocate for a professionally educated acquisition corps (Australian Department of Defence, 1997b: 49-50; and 1999a: 29).

Specialists are commonly provided by the Centres of Expertise nested into the CEP and the Industry & Procurement Divisions of the DAO. In turn, the Centres of Expertise are nurtured by the product of an extensive training program, which encompasses short courses, seminars, workshops, work rotations, trainee programs at defense contractor facilities, a bulletin, an information network, graduate courses, and post-graduate education (Australian Department of Defence, 1997a: Part 1, 1202-1218). Every one of the 14 Defence Program Managers has the responsibility of implementing competency-based training in their respective areas (Australian Department of Defence, 1995: 2).

Lately, in an effort to achieve a nationally recognized qualification, Defence has been trying to obtain the Australian National Training Authority approval for its project management training package (McPherson, 1998: 2).

How Are Acquisition Teams Organized in the Decision-Making Chain? The Department of Defence is organized in 14 Programs. Defence Acquisition Organization is one of those programs, as well the Army, the Air Force, the Navy, Intelligence, among others institutions are. Consequently, MCE acquisition is an activity centralized at the DAO level, contrasting to separate Service's MCE acquisition structures (Australian Department of Defence, 1998: Sec 1, 304).

Appendix D illustrates the DAO organizational structure. Under the Deputy Secretary Acquisition, there are three system acquisition divisions and two policy and support divisions. The system acquisition divisions are functionally organized in technology branches, which group projects by similarity. The Capital Equipment Program Division and the Industry & Procurement Infrastructure Division provides policy support, integrative oversight, and human resources to the system acquisition divisions (Australian Department of Defence, 1999b: 5).

The project manager reports to the line structure described in Appendix D. In order to improve and facilitate the reporting process, two new actions were executed recently. First, Defence implemented a project management information system, shared by the whole DAO. Second, a new board called Defence Acquisition Review Board (see Table 11) was created for monitoring complex project performances. Because this board is chaired by the Deputy Secretary Acquisition and is integrated by the five DAO division heads, a more fluid information and decision making process is expected (McPherson, 1998: 4).

After the Defence Reform Program introduction on April 1997, emphasis was applied in making the acquisition organization "a little more independent in how it undertakes its task, but much more able to be held accountable for its performance" (Australian Department of Defence, 1997b: 29). Following this trend, DAO top managers now operate as strategic and review guidance providers, delegating authority, responsibility, and accountability on technological branches and project managers. Consequently, procurement is considered a decentralized activity inside the DAO environment, because approximately 120 project managers and 12 technological branch heads perform it (Australian Department of Defence, 1999b: 5; and 1998: Part 1, 303).

After handover, the project office is disbanded and logistics support responsibilities are transferred to the receiving military service (Australian Department of Defence, 1997a: Part 4, 901).

<u>How Are Logistics and Supportability Considerations Integrated into the System Engineering Process that Frames a Weapon System Acquisition?</u>

Supportability considerations are already included in the acquisition process long before the project is approved. Actually, during the pre-approval phase (see Figure 4) when the procedure of describing and planning the acquisition of a new capability within strategic and financial constraints is performed, the first evaluation of system supportability is done. That occurs when the Major Capability Submission (MCS) is prepared and an assessment of necessary resources is estimated, and subsequently refined (Australian Department of Defence, 1997a: Part 1, 331 and 340-341).

A chain of sequential works and documents builds over this first inclusion of logistics matters in the acquisition process; all of them enhancing and improving the requirement. They are the EAS, the PMAP, the SOR, and finally the RFT and the contract. These document logistics contents demonstrate how supportability is embedded in the acquisition process.

The EAS documents the settled Defence approach for acquiring the system and its through-life support (Australian Department of Defence, 1997a: Part 4, 104). Complementing the EAS, the PMAP is a detailed document containing scheduling and responsibility assignments for ILS activities, and their corresponding previsions for test and evaluation. Typically the ILS Plan, the Test and Evaluation Plan, the Training Plan, and other logistic related plans are presented in separate volumes accompanying the PMAP Executive Summary (Australian Department of Defence, Part 4, Ch. 2, Sec. 3, Annex A).

Already in the post-approval phase of the project, the SOR is the mature expression of the Commonwealth's requirement, preferably in terms of functionality and/or performance. The SOR is part of the RFT and one of its chapters is entirely dedicated to ILS stipulations. Additionally, the tender evaluation criteria include ILS aspects in order to determine the value for money of each alternative (Australian Department of Defence, 1997a: Part 4, 410, 452 and Annex B).

As it is showed, logistic support previsions, activities, and documents are fully integrated to the acquisition process since the very beginning, and they increase in detail, complexity, and completeness following the evolution pace of the project.

One additional factor supporting this concept is the government interest of increasing Australian industry involvement as defense contractors. One of the fields where Australian industry is expected to participate the most is precisely through-life support. Consequently, a special effort is done to define ILS requirements early in the acquisition process, in order to encourage an stronger participation of the indigenous industry (Australian Department of Defence, 1997a: Part 2, 110-115).

How Is Supportability Measured and Demonstrated in the Acquisition Process? Supportability is frequently expressed as the combination of operational availability and affordability. According to Bayley and Tabbagh, the Royal Australian Air Force and the Department of Defence recognize that reliability and maintainability are crucial determinants of operational availability and affordability, and, subsequently of system supportability (118). Therefore, measuring and demonstrating R&M is synonym of measuring and demonstrating supportability.

The first stage of achieving supportability is to define a quantitative R&M requirement. This work is done during the pre-approval phase of the project (see Figure 4), when the MCS preparation takes place. Modeling plays its role at this time, allowing decision-makers to tradeoff among quantity of weapons, configuration, R&M, support, availability, and cost to accomplish the required capability. Systematically compiled throughout the RAAF, in-service failure data nurtures the modeling activity (Bayley and Tabbagh, 1995: 119-120).

The RFT contains R&M performance requirements expressed quantitatively. Tenderers are not imposed with any specific design or procedure of compliance. On the other hand, the Government establishes the objective and the prospective contractor proposes how to achieve it. Once the contractor is selected, the acquisition policy during system development is "hands off but eyes open," and requires formal demonstration of compliance with the original requirements (Australian Department of Defence, 1997a: Part 4, Ch. 4, Sec. 6, Annex B; and Bayley and Tabbagh, 1995: 121).

The preferred proof of compliance is through actual or simulated in-service R&M demonstrations, which are prearranged in the TEMP. R&M demonstrations are part of the Operational Suitability Tests corresponding to the OT&E category (Australian Department of Defence, 1997a: Part 2, Ch. 14, Sec. 8, Annex A).

In summary, R&M requirements are extracted systematically from capability needs, quantitatively and functionally expressed, monitored during system development, and tested before acceptance (Bayley and Tabbagh, 1995: 122-123).

How Is the Increasing Concern about Costs Influencing the Necessary Tradeoffs among Performance, Schedule, and Costs? Foremost, the Australian Department of Defence implemented a series of traditional acquisition actions in order to reduce and control project costs. In second place, a set of incentives is also applied to motivate contractors and Defence personnel to bring to light innovative and less expensive approaches. Both activities are going to be briefly described here.

On the traditional approach side, Australian Defence recognizes that cost is one of the three basic objectives of project management, in association with performance and schedule. Value for Money is the most important criterion for evaluating alternatives and includes LCC as one of its main determinants (Australian Department of Finance and Administration, 1998: 3). Additionally, contractors are encouraged to use a cost/schedule control system, which preferably should adjust to a set of criteria furnished by the Government. Establishing this common basis of information allows a more accurate, faster and less expensive cost and schedule decision-making (Australian Department of Defence, 1997a: Part 4, 2401-2404). CEPMAN 1 and others acquisition policy documents provide detailed instructions to implement these actions.

Since 1991, Defence has been applying an incentive program known as the Value Management Incentive Program (VMIP). VMIP consists on sharing with the contractors the amount of savings resulting from the application of new and less expensive approaches to fulfill the requirement. The process starts establishing which the essential functional requirement thresholds of a project are, and continues studying viable alternatives to accomplish them at a lesser cost. If feasible alternatives are found, a Value Management Change Proposal (VMCP) is submitted for Defence analysis and approval. When a VMCP is approved, the net benefits of its application are shared in agreed proportions by the Government and the contractor. This process is performed usually after a source of supply is defined. VMCPs can be presented by a successful tenderer, an unsuccessful offeror, and/or Commonwealth personnel (Australian Department of Defence, 1997a: Part 4, 1501-1528). In summary, VMIP not only encourages cost reductions, but also tends to prune not essential performance requirements from gold plated solutions.

Spanish Case

After being approved by the highest authorities in the Spanish Government, a military capital equipment program is not usually managed by the Ministry of Defense. Conversely, the Ministry of Defense delegates at one of the military services the management of the system acquisition and provides it with specific budgetary appropriations to afford the new program. Very recently, some incipient steps have been taken to merge some acquisition activities at the Ministry level, as we will see.

The Spanish Air Force case is developed here as representative of the country style of performing defense capital equipment acquisition.

Part of the information contained in this case was obtained from a series of telephonic and electronic mailed interviews with Lieutenant Colonel Fernando Pastor Villar from the Spanish Air Force (SAF). An AFIT Logistics Management graduate, Lt. Col. Pastor Villar is currently the chief of the Materiel Section in the Logistics Division of the SAF Air Staff. A brief vita of Lt. Col. Pastor Villar is available in Appendix H.

Which Support Elements are Addressed in Every Acquisition Process? The Spanish participation in the Euro Fighter 2000 multinational program determined an inflection point in the way that the SAF approached the logistics support issues during acquisition projects. Up to that point in history, the SAF performed merely as a receiving and distributing organization of substantial amounts of logistics support materiel, which selection had been done by vendors or foreign armed forces. The need of an effective participation in a complete supportability approach since the early stages of development and the consequent advantages of tailoring system requirements and features become crystal clear since 1989, side by side to the EF2000 program consolidation. At that time, SAF top management awareness and maturation about logistic issues conducted to the adoption of the ILS approach in acquisition (Dueñas Sanchez, 1998a: 963).

The program manager must coordinate and propose logistics plans according to the ILS concept and the program office must include ILS as one of its functional areas. Concurrently, the following ILS elements are recognized (Spanish Air Force, 1993:16-17):

- Maintenance
- Personnel
- Training
- Supply
- Facilities or Infrastructure
- Support Equipment
- Technical Data
- Computer Support
- Packaging, Handling, Storage, and Transportation

An important effort has been applied since 1994 by the SAF to develop and implement an integrated logistics information system, which is called SL2000. The SL2000 program primary objective is to provide an integrated system that assures adequate logistics support to the SAF materiel, using updated logistics practices and standards like ILS, CALS, LCC, and AECMA. SL2000 should provide reliable decision making information, reduce operational costs, propose a new logistics doctrine, integrate activities from all the logistics elements, and increase weapon system readiness. The first two segments of the system are already working in the SAF and a complete implementation is anticipated for the year 2002 (Almagro González, 1998: 968 and 971). Being already in use for the EF2000 program, the first segment includes the Initial Provisioning Module, which is based on the ILS concept application (Ibañez Martínez, 1998: 972-974).

How are Supportability Requirements Stated in Order to Translate Them into Cost Effective Programs? Directive 20/93 and the PAPS Handbook contemplate in similar ways how to manage supportability requirements during the first four phases of the PAPS. According to these documents, logistics requirements must be extracted from the mission need document, transformed in functional requirements, and continuously improved until the solution for the operational need is completely defined at a system level of aggregation (Spanish Air Force, 1993: 4-8, and 10-11; NATO International Staff, 1989: 15-19). At milestone 4, "performance requirements and detailed requirements regarding the technical characteristics are established so as to meet the operational requirement under the best conditions" (NATO International Staff, 1989: 19).

From these documents, it is possible to infer that logistics support requirements are present since the very beginning of the acquisition process and are considered an important part of the project definition. However, doctrine also enacts that supportability requirements are to be termed in a detailed design manner and as disconnected entities from performance requirements.

According to recent trends, this doctrinal exigency has been partially relaxed. Program offices are increasingly tending to replace detailed for performance termed supportability requirements, while giving ampler freedom to contractors in the selection of design solutions that satisfy the need (Pastor Villar, 1999).

This shift in the logistics requirement terminology should be understood as an incipient tendency that is not strong enough to alter the written doctrine yet.

Requirements are discriminated in two levels of criticality. They are threshold, which is a crucial requirement that if not achieved jeopardizes the project success, and objective, which is a desirable goal (Spanish Air Force, 1993: 8).

How Are Acquisition Teams Constituted to Take Charge of Acquisition Logistics Issues? During the first three phases of the PAPS when general alternatives are considered and requirements are determined and improved, a Working Group performs most of the work. This working group is comprised of a representative from every Air Staff Division, a user representative, and delegates from the MALOG and the MAPER (Spanish Air Force, 1993: 5).

After the Staff Requirement Document approval at the end of phase 3, the working group is disbanded and replaced by a program manager and a team of specialists clustered in a program office. The program office is constituted by personnel with knowledge in operational issues, engineering, ILS, contractual and legal issues, and financial matters. Depending on the complexity and importance of the program the number of specialists in each area is adjusted, as well as if they will work part-time or full-time in the program. Additionally, user and Air Staff representatives are integrated to program office personnel in the Overview Group that evaluates the program progress and advises the Steering Committee (Spanish Air Force, 1993: 16-18). The presence of logisticians in all these groups is strongly enacted by the NATO's Handbook on the PAPS (66-68).

Representatives participating in team working are not usually allowed to make decisions committing resources on behalf of their organizations and their actions require validation from their bosses (Pastor Villar, 1999).

The organization in charge of the program management is responsible of satisfying the program office personnel needs (Spanish Air Force, 1993: 17). In general, for weapon system acquisitions the organization in charge is the Systems Directorate of the Logistics Support Command (Pastor Villar, 1999).

No structured training program in acquisition matters is available to SAF personnel. They construct their own expertise only on basis of their work experience or some occasional course (Pastor Villar, 1999).

Summarizing, logistician's participation is mandatory in the acquisition teams since the program outset. However, team members have weak training and scarce level of empowerment.

How Are Acquisition Teams Organized in the Decision-Making Chain? In the SAF the milestone authority is always the Chief of Staff. On the other hand, the program manager generally reports to the Systems Directorate of the Logistics Support Command organically, and to the Steering Committee functionally (Spanish Air Force, 1993: 15). The typical chain of command for a program manager is displayed in Figure 5.

The program manager holds great freedom in the program decision making as long as he respects the budgetary constraints and the crucial program objectives. His function as general coordinator among organizations involved in the program is vital because the level of empowerment of Directorate and Command representatives is somewhat limited. The program office disbands after the system is released to the user and the Logistics Support Command take upon itself supportability duties (Pastor Villar, 1999).

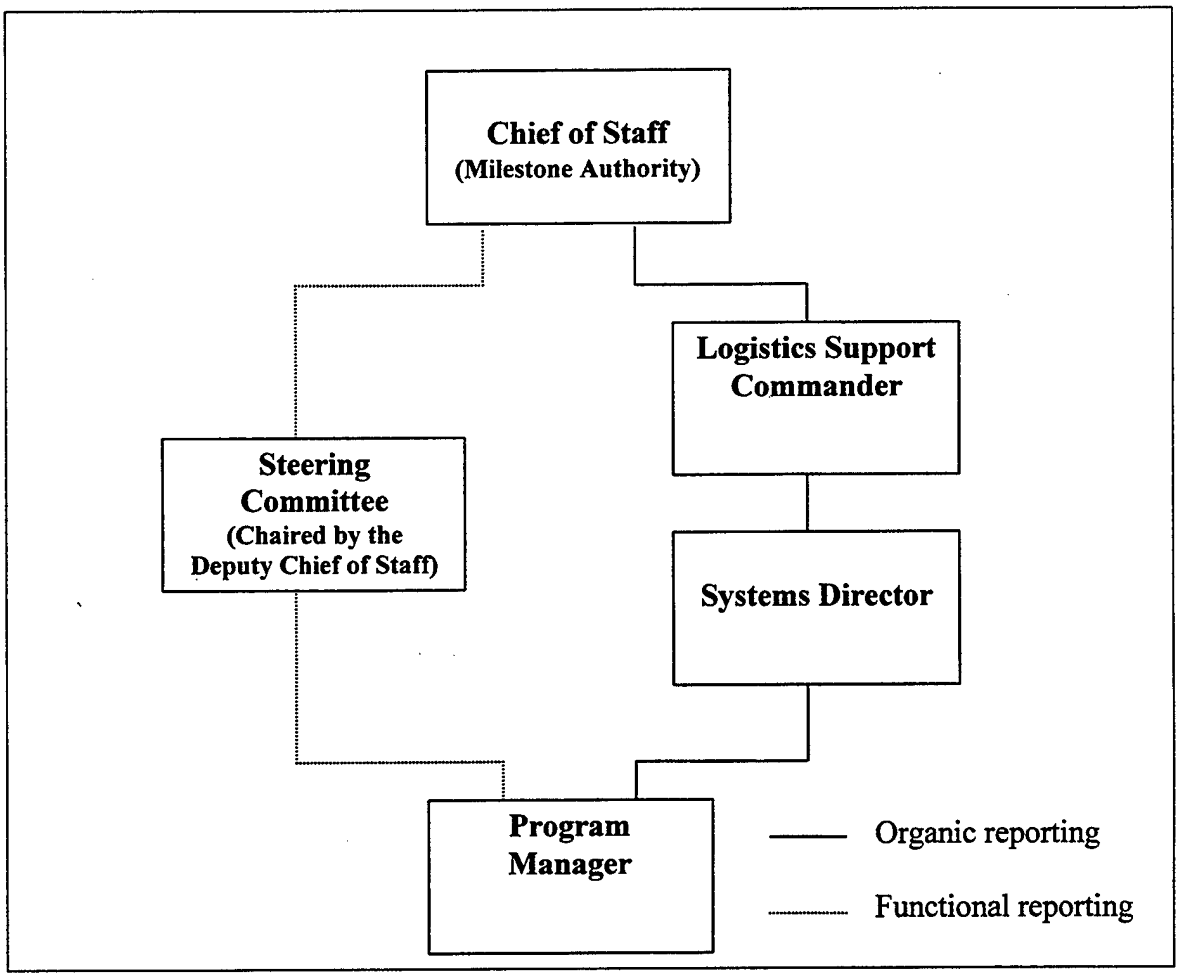


Figure 5. Program Manager Chain of Command in the Spanish Air Force

How Are Logistics and Supportability Considerations Integrated into the System Engineering Process that Frames a Weapon System Acquisition? Logistics implications appears for the first time at phase 1, when an Evaluation Group reporting to the Planning Division of the Air Staff analyzes the Operational Need Document issued by the user. After studying and validating the need, the evaluation group work consists on transforming it in a set of functional requirements, including logistics ones (Spanish Air Force, 1993: 4-5).

Starting at this point, a progression of analysis and documents is developed, which continuously tends to complete, improve, and enhance those basic supportability requirements. The Working Group generates first the Outline Staff Target Document, the Staff Target Document later, and finally the Staff Requirement Document, all of them after studying and analyzing the mission need and different solution alternatives in phases 1 to 3. This increasingly detailed process concludes with the final requirement definition that must include complete ILS provisions, LCC estimations, and risk evaluation (Spanish Air Force, 1993: 10-11). It is correct to conclude that supportability is firmly incarnated in the requirement analysis portion of the acquisition cycle.

On the contrary, Spanish Air Force doctrine is not profuse about logistics support consideration during the design, development, production, in-service, and disengagement portions of the acquisition process. Directive 20/93 broadly establishes that the program manager must conduct his planning and work using the ILS concept framework (16) and recognizes NATO's PAPS doctrine as a source of supplementary doctrine (1).

Reliability, maintainability, and availability, as well as LCC must be continually evaluated during all phases because of their direct impact on alternative evaluation, support concept, and feasibility (NATO International Staff, 1989: 66).

How is Supportability Measured and Demonstrated in the Acquisition Process? When requirements are prepared, supportability is assessed quantitatively using measures of reliability, maintainability, and availability. Besides, affordability or LCC is being increasingly used instead of purchase price when evaluating alternative solutions (Pastor Villar, 1999).

The Systems Directorate of the MALOG clusters a team of R&M engineers that not only provides advice and support to the program manager during the acquisition process, but also centralizes and manages the R&M information from the whole active fleet. This qualified group of engineers contributes its knowledge to every SAF acquisition program and receives continuous training updates during its work at multinational projects like the EF2000 and the Future Large Aircraft (FLA). Furthermore, a group of cost specialists in the MALOG environment is dedicated to LCC calculations for the in-service aircraft, and provides expertise to the program office when needed (Pastor Villar, 1999).

Program managers include supportability tests during reception trials in order to verify requirement achievement in the R&M fields. These tests are performed using average trained support personnel and simulating actual conditions of operation and maintenance. Additionally, during the in-service phase, supportability assessments are programmed to corroborate that reliability and maintainability values under normal and prolonged conditions of use are still acceptable (Pastor Villar, 1999).

The integrated logistics system SL2000 includes a Fleet Activity Programming and Control Module, which is currently under implementation. The outcomes of this subsystem will facilitate the weapon system readiness assessment and the R&M weaknesses identification (Dueñas Sánchez, 1998b: 983-984)

<u>How is the Increasing Concern about Costs Influencing the Necessary Tradeoffs among Performance, Schedule, and Costs?</u> The balance among performance, schedule, and costs is a concern recognized by doctrine since the beginning of the acquisition process (Spanish Air Force, 1993: 9-10). The type of costs considered is the LCC and at least performance thresholds must be achieved. First, the working group and later, the program manager are demanded to permanently watch out the possible tradeoffs for achieving the best solution. Criteria for defining what is the best solution in every single case are left to top program management officials' discretion.

Costs are not only considered a permanent concern in the acquisition process, but there are also signs of an incipient program for reducing costs and treating them as an independent variable.

First, the progressive replacement of military for commercial standards, where it is possible, is one of the steps taken in reducing costs (Pastor Villar, 1999).

Second, cost reduction is part of the incentives to implement the SL2000 system. SL2000 is expected to reduce operational costs, which is the largest contributor to LCC, in a still unknown percentage (Almagro González, 1998: 968).

Finally and very recently, a Ministry of Defense initiative has emerged to centralize the purchase of a substantial number of helicopters to be used not only by the armed forces, but also by the security forces. This joint purchase is aimed to reduce costs and to encourage technology transfer by means of appropriate offsets, all based in the large number of aircraft involved. Additionally, this operation includes a requirement of depot level maintenance outsourcing, which is seen as a pilot case in Spain. A series of preliminary contacts with the Spanish Association of Defense Materiel (AFARMADE) has given promising cost perspectives to this operation, which would be the first important acquisition not performed individually by the military services (Pastor Villar, 1999).

Portuguese Case

In Portugal, the majority of the acquisition process is performed inside the environment of each military service and the rest at the Ministry of Defense level. This research is focused on the Portuguese Air Force case, which is considered a genuine example of all the service's procedures.

Except when other source is expressly denoted, all the information in this case was collected via a personal interview with Colonel Saul António Dias Pascoal. Colonel Pascoal is currently the Portuguese Air Force Liaison Officer at the U.S. Air Force Security Assistance Center (AFSAC), Wright-Patterson Air Force Base, Ohio. He is an aeronautical engineer, whose experience includes six years as F-16 Program Manager and previous active participation in the A-7P Program for the FAP. A brief vita of Colonel Pascoal is attached in Appendix I.

Which Support Elements are Addressed in Every Acquisition Process? The ILS concept is not part of the FAP doctrine. However, during the acquisition process the following logistic areas are normally addressed.

- **Maintenance**, which is frequently split in electronic and aircraft sub-areas. Maintenance also is accountable for support and test equipment previsions.
- **Supply,** which also includes packaging, handling, storage, and transportation.
- **Personnel**
- **Training**, which is usually divided in technical and flight sub-areas.
- **Publications**, which covers technical and flight manuals, documents and data.
- **Data Systems,** which deals with computer resources and their support.
- **Infrastructure** or facilities.
- **Armament,** only when applicable.

Although the FAP does not apply formally the ILS approach, it becomes clear that the list of areas addresses almost all the ILS elements, individually. Design Interface is the only one missing element.

In summary, while most of the ILS elements are present in the FAP acquisition process, the absence of an integrative approach would perhaps allow some room for overlapping tasks and/or for insufficiently addressed borderline subjects.

How Are Supportability Requirements Stated in Order to Translate Them into Cost Effective Programs? In Portugal, military capital equipment acquisition is regulated by the Military Programming Law (LPM from its Portuguese name *Leis de Programação Militar*). This law and the participation of Portugal in the NATO planning activities compel planners to use a Biannual Force Planning Cycle (CBPF). Table 13 shows a concise outlook of what is done and who the performers are in the CBPF.

Passing through the CBPF steps, an operational need statement is improved and complemented. As Table 13 shows, logistics resources are one of the aspects that must be addressed before including capital equipment need as a LPM item. Nevertheless, logistics requirements are still termed very generally at that time.

Table 13. Portuguese Biannual Force Planning Cycle (Campos Almeida, 1997:18)

	Even Year	**Odd Year**		**Even Year**		
PRODUCT	Situation Appraisal: -Political –Economical –Personnel –Military	Ministerial Defense Directive	Force Proposals	National Force Objectives	Plans: -Forces -Armament -Logistic Resources -Communications -Intelligence	Military Planning Law (Endures 6 years, with revision every 2 years)
PERFORMER	MDN EMGFA	MDN	EMGFA Military Services	MDN (approve)	MDN EMGFA Military Services	MDN EMGFA Military Services CCEM CSM CSDN CM AR

Where,
MDN: Ministry of National Defense
EMGFA: Armed Forces Join General Staff
CCEM: Chiefs of Staff Council
CSM: Superior Military Council
CSDN: Superior National Defense Council
CM: Ministries Council
AR: Republic Assembly

After the inclusion of a program in the LPM, a program office is established in the environment of the most related military service. There is no specific directive or regulation establishing phases and milestones in the program. However, the program office must prepare a document called Program Reference Document, which for every project describes requirements, goals, stages, audit points, responsibilities, and directions for the development. After approval of the Program Reference Document by the FAP Chief of Staff, this book becomes the program prime guidebook.

Under the Program Reference Document guidance, the program office continues developing the broad requirement included in the LPM until the request for proposal stage is achieved. The statement of requirement that accompanies the request for proposal document contains two parts, the operational requirement, and the logistics support requirement. This last requirement is usually written in terms of readiness objectives for typical usage rates and deployment schemes. Affordability, the parameter that complements readiness to define supportability is generally not considered in the logistics requirement. It is also customary to define mandatory requirements and negotiable ones.

The operational part of the requirement is frequently developed with more detail and relative weight than the logistics segment.

General Antonio de Jesus Bispo recognizes that ambiguity in the readiness and affordability requirement phrasing is one of the major reasons behind budgetary prevision failure to achieve user need satisfaction in Portuguese military acquisition (Bispo, 1996: 11).

How Are Acquisition Teams Constituted to Take Charge of Acquisition Logistics Issues? Team size and integration varies with the complexity and importance of the program. A typical team integrates as shown in Table 14.

Only a reduced number of the members of a team are fully assigned to the program office, the rest have functional linkage to the program while keeping reporting to the Logistics Command or to the Personnel Command. Appendix J displays the organizational structures of the Portuguese Air Force and its Logistics and Administrative Command, where it is possible to identify the specific Directorates supplying personnel to the program (Portuguese Air Force, 1999). This *modus operandi* is intended to exploit efficiently the reduced number of available specialists and to achieve a progressive immersion of the Logistics and Administrative Command and the Personnel Command in the new system issues. FAP authorities encourage this type of dual organizational structures, linear plus functional, as a method of increasing organizational communication speed while keeping enough vertical command authority (Macedo Cardoso Costa Rodrigues, 1996: 35).

Table 14. Members of a Typical FAP's Capital Equipment Acquisition Team

Position	Quantity		Remarks
	FT	PT	
Program Director	1	-	General Officer – Provides guidelines and broad oversight
Program Manager	1	-	Colonel - Responsible for the day-to-day management
Maintenance	1	2	From the Directorates of Electronics, Mechanics and Aeronautics, and Supply.
Supply	1	2	
Personnel	1	2	From the Personnel Command
Training	1	2	From the Personnel Command and the Logistics Command.
Publications	1	2	From the Logistics Command
Data Systems	1	2	From the Logistics Command
Infrastructure	1	2	From the Directorate of Infrastructure
Armament	1	2	From the Directorate of Mechanics and Aeronautics
Future Users	1	2	Pilots from the Operations Division of the FAP Staff. They will be Squadron Leaders or users of the system
Note: FT means full time and PT means part time members			

Team members representing Directorates and Commands are not empowered to make decisions and commit resources on behalf of their organizations during the program meetings. They have to submit the information to their respective Directors for approval. The Chief of Staff or the Deputy Chief of Staff clears any dispute among the program and the rest of the permanent organizations.

The acquisition force receives training in administrative and general procurement issues; however, they usually do not undergo advanced acquisition training like postgraduate education or equivalent courses. It is important to emphasize that experience gained in previous programs is capitalized via recycling the group of acquisition specialists among the set of in-progress programs.

How Are Acquisition Teams Organized in the Decision-Making Chain?

Being a general officer, the program director habitually reports directly to the FAP Deputy Chief of Staff. Appendix J shows the Deputy Chief of Staff position into the FAP organizational structure.

The Program Director has ample attributions to make decisions related to the program development that do not alter significantly the original project definition and the budget approved by the Republic Assembly. Because a program is usually managed by one of the military services, the respective Chief of Staff is periodically informed of the program progress and retains the last approval authority for the significant determinations. If notable new features and/or higher costs are considered indispensable, the Chief of Staff must conduct an extraordinary request to the Ministry of Defense and eventually to the Republic Assembly.

The Program Director and the Program Manager generally maintain a smooth functional relationship with the Logistics and Administrative Command and the Personnel Command. The program nurtures of manpower and expertise from those Commands. Logistics support accountability is transferred to the Logistics and Administrative Command at the end of the initial provisioning process, when the program office is dispersed.

The already mentioned Program Reference Document provides a broad guide to manage the project, including schedule, milestones, and proper decision authorities.

How Are Logistics and Supportability Considerations Integrated into the System Engineering Process that Frames a Weapon System Acquisition? Despite not covering affordability, logistics requirements are included early in the acquisition process. As it was already discussed, they appear broadly defined for the first time when the Military Programming Law is prepared and approved.

The Program Reference Document makes the Program Director responsible for improving and completing the logistics requirements. The Program Director is also accountable for managing the introduction of the system and its support into the military service organization. Actually, the program office must conduct every action oriented to procure the system and its initial logistics package, which must be usually enough for supporting two years of operation.

After formally accepting the new weapon system and its initial support, the program office is disbanded and the logistics responsibilities for the system are transferred to the Logistics and Administrative Command.

Most of the weapon systems acquired by the Portuguese Air Force are already in service in other countries. Therefore, chances to influence the design solutions from a logistics standpoint are limited and Portuguese acquisition team members tend to utilize foreign experiences as references in their logistics support definition.

Life cycle cost concept is still little known and little applied. Recently, some efforts have appeared to replace ownership costs for tag prices as a decision-making parameter and to start considering affordability issues (Vaz Afonso, 1996: 13). Advocates of this initiative promote an improved LPM that associates support costs to the initial investment prices of the programs, among other reforms (Campos Almeida, 1997: 20).

How Is Supportability Measured and Demonstrated in the Acquisition Process? Reliability, maintainability, and availability are concepts managed only conceptually during the acquisition process. Similarly, affordability and LCC are not practically applied in procurement. Additionally, there is no group of Portuguese specialists in these issues. In consequence, the FAP is impeded of using actively this set of parameters in the logistics support qualitative and quantitative design. The program members do not have other alternative than trusting vendor proposals about logistics support or requesting help from other NATO countries operating similar systems. After that, the information received is tailored to the particular circumstances of that Portuguese purchase. Tailoring is performed on grounds of two criteria. First, the ceiling imposed by the amount of money available for the whole purchase usually limits the support item acquisition. Second, exploiting the information produced by the Integrated System of Maintenance and Supply Management (SIGMA), it is possible to identify

R&M weaknesses in certain parts currently in use in the FAP. If those problematic parts are the same or similar to those being purchased, then, logisticians give particular attention to their quantity, quality, and logistics support.

Introduced in 1976, the SIGMA was used as an important assistant in performing several supply and maintenance tasks, like inspection programming, inspection supply need determination, and failure register. Currently, the system is under expansion and update, improving its ability to obtain crossed information from several databases. From the supportability standpoint, the system and its exploitation are crucial because they embody the basic information to support the functioning of any future tool aimed to determine readiness and affordability in the FAP.

Usually, there are no previsions for supportability testing in the acquisition process.

How Is the Increasing Concern about Costs Influencing the Necessary Tradeoffs among Performance, Schedule, and Cost? Remembering that in this case cost is referred to purchase price and not to LCC, the most important financial constraint is simply the total amount of money that can be spent to acquire the system and its initial logistics support. As long as the total price does not surpass the budgeted amount, the implicit hierarchy in the tradeoffs among performance, schedule, and cost recognizes performance as the most important parameter, costs slightly behind, and finally schedule.

One of the actions taken to reduce costs is the increasing use of commercial standards instead of military ones.

Furthermore, there is increasing concern to help developing the indigenous industrial sector in order to achieve more participation of the Portuguese contractors in support activities. An acquisition strategy that privileges national industry in the military procurement is one of the instruments currently under examination (Dos Santos, 1998: 22-23). Motivation for these concerns is related to costs, but also is associated to strategic and political objectives.

Integrative Summary

This summary is intended to provide, at a glance, a consolidated synopsis of the different country's acquisition logistics features. On behalf of clarity and comprehensiveness, some degree of detail must be sacrificed. However, the reader is still able to consult the specific country case for ampler information on the subjects exposed. Summary information is consolidated in Tables 15 to 18, which columns represent the condensed answers to each of the investigative questions explored in this research.

Table 15. Integrative Summary of Acquisition Logistics Issues (Part 1)

	Supportability Elements	Supportability Requirements Terminology
United States	• ILS elements • Integral approach to logistics • Supportability is a part of the system performance	• Obligatorily expressed in quantitative and performance terms. Must be specific, measurable, and testable • What is needed, not how to do it • Objectives and thresholds • Minimize the number of key performance parameters • SOO leaves maximum design freedom to offerors. • Must be established since outset
Austra-lia	• ILS elements • Integral approach to logistics • Supportability is starting to be considered part of the system performance	• Obligatory expressed in quantitative terms • Preferably expressed in performance terms • What is needed, not how to do it • Objectives and thresholds • SOR encourage innovative offeror approaches • Must be established since outset
Spain	• ILS elements • Integral approach to logistics • Supportability and performance issues are independent	• Detailed design terms • Incipiently shifting to performance termed • Objectives and thresholds • Must be established since outset
Portu-gal	• Intuitive list of logistics elements • No integral approach to logistics • Supportability and performance issues are independent.	• No specific doctrine • Mixture of partially performance and design termed • Objectives and thresholds • Sometimes ambiguous and insufficiently developed • Must be established since outset

Table 16. Integrative Summary of Acquisition Logistics Issues (Part 2)

	Acquisition Teams Constitution and Training	Acquisition Teams Organizational Aspects
United States	• Comprehensive and empowered groups • Integrated Product Teams • Teamwork at all decision levels • Logisticians included in all decision levels • Great effort in training and career development • Certification necessary for contracting and PM positions	• PM into the service environment, but MDA at DoD • Acquisition policies, procedures, and crucial decisions made at DoD level • PM has increasingly ample decision capability • Program Office remains in charge along the system whole life
Austra-lia	• Comprehensive and empowered groups • Integrated Product Teams • Teamwork at all decision levels • Logisticians included in all decision levels • Great effort in training and career development	• PM and MDA at Department of Defence level • Acquisition is integrally managed at ministerial level • PM has increasingly ample decision capability • Project office disbands after handover
Spain	• Comprehensive but little empowered groups • Logisticians included in every team • No advanced acquisition training and meager career development	• PM and MDA into the military service environment • Acquisition policy, procedures, and crucial decisions made at service level. • Logistics Command is in the PM chain of command. • Ample PM's decision freedom • Project office disbands after handover
Portu-gal	• No doctrine about team constitution • Comprehensive but little empowered groups • Logisticians included in the teams • No advanced acquisition training and incipient career development	• PM and MDA into the military service environment • Little acquisition doctrine. Crucial decisions made at service and ministry level • Logistics Command in PM's functional chain of command • Ample PM's decision freedom • Program office disbands after handover

Table 17. Integrative Summary of Acquisition Logistics Issues (Part 3)

	Supportability Integration in the Acquisition Process	Supportability Measurement and Demonstration
United States	• Embedded in every program phase • Particularly valuable at early phases • Aimed to influence design and define optimal set of logistics resources • Allows cost effective operational/ /logistics tradeoffs • Logistics previsions strongly incorporated in the design core	• Two combined measures: availability and affordability • For practical purposes A is measured through R & M • LCC measures affordability • Sub-optimal translation between operational and design parameters • Supportability tested at DT&E, OT&E, and pre/post deployment supportability assessments
Austra-lia	• Present in all program phases • General previsions at the program outset, improved during acquisition process, very well defined at the SOR stage.	• Two combined measures: availability and affordability • For practical purposes A is measured through R & M • LCC measures affordability • Contractor must formally demonstrate compliance with R&M requirements during OT&E under in-service conditions.
Spain	• Present in requirements analysis part of the acquisition cycle. Scarce logistics doctrinal provisions from design to disposal. • General previsions at the program outset, improved during acquisition process, very well defined at the SOR stage.	• R, M, and A are used to prepare requirements and trials. • LCC use is incipient but growing fast • R, M, and A are tested during reception trials simulating actual conditions. There are also post deployment R&M assessments
Portu-gal	• Readiness requirements are present during all phases. Affordability not considered in a systematic manner	• There are no specific, measurable and testable R, M, A, and LCC requirements or measurements. They use other NATO's nation experience • First steps are being done with improved R&M data collection and processing system • No supportability trials

Table 18. Integrative Summary of Acquisition Logistics Issues (Part 4)

	Costs importance versus performance and schedule
United States	• Costs are measured using LCC • Formerly relegated, now cost is as important as performance and schedule • CAIV concept trims performance and schedule to keep costs inside an acceptable range. Provides cost reduction incentives • Permanent LCC evaluation. Some independent estimations necessary too • C/SCSC helps costs decision making • CPIPT at program level and CAIG at OSD level
Australia	• Value for Money alternative evaluation criterion use LCC as main determinant • C/SCSC helps costs decision making • Not essential performance and schedule requirements must be pruned to keep costs between limits • VMIP encourages innovation to reduce LCC
Spain	• LCC is the measure of cost • Doctrine shows permanent concern for tradeoffs among costs, performance, and schedule • Incipiently, cost is given strong and independent importance. Using commercial standards, updating of SL2000 system, and first substantial joined purchasing project provide evidence
Portugal	• LCC is rarely used • Cost is a concern but relegated after performance issues

V. Proposal for the Argentine Air Force

Introduction

This chapter begins presenting the current situation of acquisition logistics in the Argentine Air Force (FAA) environment. This situation was already described briefly in Chapter I, when the background and statement of the problem were introduced. Nevertheless, it becomes necessary to refresh and go deeply into those issues now. Attuning to this research objective, discussion stresses the supportability weaknesses of the acquisition process.

Next, a set of critical factors for improving the FAA's major system acquisition process is presented and discussed. These critical factors are extracted from the case studies detailed in Chapter IV, adapted to the Argentine reality, and proposed as groundwork for a future comprehensive redesign of the FAA's acquisition system.

It is relevant to recognize that a complete plan for developing an acquisition system achieving cost effectiveness in the tactical/operational logistics, via improving the acquisition logistics process is not the expectable outcome of a one-man research. Conversely, not only a lot of teamwork is necessary, but also a strong commitment from the entire organization becomes indispensable because of the many issues requiring considerable collaborative effort. The set of critical factors presented in this chapter is expected to represent an initial step towards such ambitious acquisition reform.

Finally, a conclusion is presented, as well as opportunities for further research.

Current Facts and Weaknesses in the FAA's Major System Acquisition Process

When one of the military services identifies an operational need, the Ministry of Defense assumes responsibility for evaluating and validating that need. Contemporarily, the Joint Chief of Staff advises the ministry and verifies need compatibility with the joint military planning (Argentine Congress, 1998: art. 17,18, and 22). After ministerial validation, the Congress must approve specific appropriations and one of the military services is commissioned to develop the project. In the Argentine Air Force, the Project Directive constitutes the basic doctrine for conducting a new weapon system acquisition program.

Integrated logistics support is not part of the logistics doctrine and it is still a little known concept. Consequently, ILS' "blending of all elements of logistics into a coherent effort that results in the system being supported when it is fielded (Electronics Systems Center, 1996: 2)" is not exploited by the FAA.

The FAA recognizes a set of general logistics resources, which are used by PMs when trying to cover logistics issues of the project. They are personnel, materiel, facilities, and finances (Argentine Air Force, 1997: 10-12). These logistics resources are very broadly defined, assuring neither a total logistics approach nor absence of overlapping actions.

When an Operational Requirement (RO) is prepared, logistics and performance requirements are deeply differentiated. Operational performance requirements are much more detailed and developed than the logistics support ones. In general, supportability conditions are not established quantitatively. Moreover, the RO form does not make mandatory logistics requirements (Argentine Air Force, 1994: Annex 7). Under these circumstances, supportability stipulations are usually fuzzy and considered less important than operational ones.

When the successive phases of the Planning and Development Period (see Appendix B) are being accomplished, there is insufficient treatment of the logistics aspects of the project. There is no evidence that supportability is considered as one of the crucial criteria for shaping the system since the conceptual phase. Conversely, logistics aspects are not generally expected to be boarded until the operational ones are completely defined.

Acquisition teams generally include only a minority of personnel with logistics background, which is especially true during the crucial early phases. Very frequently, personnel integrating the project teams have not received advanced acquisition training or any kind of acquisition education at all. On the other hand, there are only a reduced number of personnel accrediting some recent acquisition experience, because of the many years without new weapon system purchases.

Supportability responsibilities of the PM are limited to coordinate with the logistics organizations the future provision of logistics support. The PM is not directly accountable for the system support (Argentine Air Force, 1994: Annex 6). Additionally, Project Directive prescriptions related to acquisition logistics performed by the Materiel Command are not clearly defined and leave room for inconclusive interpretations during the planning and development period (Argentine Air Force, 1994: 8, 10, and 11). It is necessary to achieve the production and deployment period to find more concern about logistics aspects of the project (Argentine Air Force, 1994: 14).

According to the Project Directive, the PM should report to the Systems Directorate during the planning and development period and to the Materiel Command during the production and deployment period. However, recent experiences have demonstrated that the actual PM chain of command is variably modified according to the circumstances, which is especially true in the most important projects. Sometimes the Systems Directorate was bypassed and, at least once, an important project reported to the Operations Command. Appendix K contains the most important hierarchical relationships of the PM in order to facilitate understanding. Consequences of this variability are lack of clarity in the PM relationships with other organizations, scarce commitment to the project goals from outsider organizations, and imperiled experience accumulation and filing. On the other hand, weak PM logistics responsibilities and late participation of the Materiel Command in the program decision making seriously jeopardize a smooth and cost-effective in-service transition of the new system.

Teamwork is intensely used inside the program office. However, there are difficulties to incorporate other organization representatives, and when this is achieved, those representatives are usually not empowered enough to commit resources on behalf of their directors. This is particularly true during the first phases of the project.

Under these circumstances, supportability is not embedded in the core issues of the project until the production and deployment period. Consequently, it is already late for influencing the system design and for preëmpting financial assets to obtain the optimal set of logistics resources. Likewise, tradeoffs between operational and logistics parameters are difficult because of the initial underdevelopment of the logistics aspects at the early phases of the project. When logistics aspects are finally developed during the production and deployment period, those tradeoffs are still more difficult because the design has been already frozen for a long time then.

Measurements of supportability - readiness and affordability - are little used concepts. The FAA does not have a team of R&M specialists working in acquisition programs. Moreover, R&M data from the current fleet is scattered and not systematically translated into useful information for decision making. On the other hand, LCC is a concept of recent inclusion in the FAA doctrine (Argentine Air Force, 1997: 4) and still little applied to evaluate alternatives (Argentine Air Force, 1994: 7). Provisions for supportability demonstration before and after materiel acceptance are infrequent.

Project Directive makes some provisions for tradeoffs among performance, costs, and schedule, especially during the feasibility phase. If any performance requirement has to be adjusted, a feedback loop to the user and logistic command must be established (Argentine Air Force, 1994: 9). Performance is relatively more important than costs and schedule in the decision-making process, while objective and threshold values for each requirement must not be mandatory stated. Besides, LCC is not the usually considered concept of costs, but price tags, which include the core system and some degree of initial provisioning (Argentine Air Force, 1994: 9).

Critical Factors for Improving FAA Acquisition Logistics Process

After analyzing the major capital equipment acquisition process of the United States, Australia, Spain, and Portugal, and after refreshing the weaknesses of the FAA process, it is time to use the whole package of information to distill a set of critical factors for improving the FAA process. According to the character of this research, those critical factors are mainly related to acquisition logistics aspects and only involve other areas when it is indispensable.

In general, propositions are presented to complete, improve, and make more effective the outcomes of the Project Directive application. This fact not only recognizes that many aspects of that directive are still up-to-date, but also encourages using it as the basal line of any future acquisition reform.

The proposed improvements are grouped in three areas, which are doctrine, procedures, and organization. This classification responds merely to the general character of each proposed change, because it is evident that sharp frontiers do not exist among the three areas. Table 19 summarizes the proposed improvements, which are later discussed.

Table 19. Proposed Improvements to the FAA Acquisition Process

Area	Proposed Change
Doctrine	• Introducing ILS concept. • Introducing LCC concept. • Introducing R&M concepts.
Procedures	• Improving supportability requirements • Inclusion of supportability as a core issue in every phase of the project
Organization	• Acquisition team composition • Acquisition team training • PM chain of command

<u>Introducing ILS Concept.</u> A more comprehensive and coherent approach to logistics support is necessary to provide the PM with a tool that ensures all the logistics aspects are receiving due attention. The typical ILS elements can be tailored, but basically must include maintenance planning, manpower and personnel, supply support,

support equipment, training and its support, technical data, computer resources support, facilities, PHS&T, and design interface.

It is important that ILS be integrated not only to the Project Directive, but also to the basic and applied logistics doctrine body. Current doctrinal definitions of logistics resources are very ample, and implicitly include ILS elements. However, because of being so broad, doctrine does not help to identify, analyze, and manage the logistics support components of a weapon system.

ILS concept is a concept widely embraced by many countries in the world, including those that are subject of this research, except Portugal.

Introducing LCC Concept. Recently, the FAA has recognized LCC as one of the cardinal logistics criteria (Argentine Air Force, 1997: 4). However, this concept has not spread to other doctrinal documents yet, and let alone has penetrated the organizational culture.

LCC should be the parameter in use when comparing alternative costs, making project decisions, analyzing tradeoffs, and forecasting budgets. The Directive Project should include LCC as one of its main criteria, cost calculations should be performed following LCC methodology, and deciders should be aware of the negative consequences of replacing LCC by tag prices.

Into the Materiel Command environment, a team of cost specialists should be created and trained for gathering and processing data, calculating, and registering LCC of the most important weapon systems currently in use. LCC information is permanently useful for making operational and logistics decisions at any point of the system life cycle.

The same group of people would be able to provide estimations and advice to the PM during a new system acquisition process.

LCC are used by three of the four investigated countries. The exception is Portugal, which acquisition system is the least developed one. Nonetheless, even the FAP is incipiently struggling to incorporate the LCC concept to its procedures.

Introducing R&M Concepts. R&M are conceptually known but little applied in the FAA decision-making process. Deciders are not usually familiar with practical applications of such tools. Consequently, they cannot take advantage of their benefits and power. On the other hand, R&M calculation and application were well known and applied subjects in the former Military Aircraft Factory (FMA) before its transformation and privatization in the early nineties.

The Materiel Command should explore among the remaining group of former FMA's engineers still working at the Aeronautical University Institute (IUA) to constitute a R&M team. If this exploration does not succeed, a team should be trained in R&M calculation and exploitation. Despite what its origin is, this team must devote its effort to gather, analyze, and systematize current weapon system disperse data about failure rates, repair times, transportation and waiting times, spare part use statistics, in-service aircraft percentages, and other related parameters. Using these data, the team must be able to provide valuable information to all-level decision-makers about when and where investing effort in supply and maintenance, and about current decisions future impact on availability.

These day-to-day advantages of employing an R&M team have important correlation with the new weapon system acquisition process. Effectively, experience and methodology amalgamated by the team on current systems constitute the basis for providing expertise to the PM and its team. Representatives from the R&M pack should work into the acquisition teams helping to establish concrete, measurable, and testable supportability requirements; determine initial and follow-on provision lists; dimension organizational, intermediate and depot level requirements; and set the correct number of aircraft to buy in order to accomplish the mission under actual conditions of supportability.

R&M team creation and work are absolutely crucial to avoid expending resources in buying lists of items prepared by vendors, which cannot be scrutinized thoroughly and rationally because the acquisition team lacks the basic information and the expertise to do that, no matter how much good will is invested.

The Project Directive should pay due attention to this aspect of the acquisition work and include specific provisions related to R&M evaluation. From the analysis of the case studies, it becomes clear that all of them keep a central role to R&M in their acquisition processes.

Improving Supportability Requirements. Supportability should be considered one of the parameters that integrate the system performance because readiness and affordability determine the actual force size. Contrasting to the present situation, supportability requirements should be part of the first version of the RO, and the PM ought to work with the user in completing and improving them along the road.

From the multiple case studies performed, it becomes clear that supportability requirements should be concrete, measurable, and testable and they should be defined and refined at the same time than the operational ones, in a balanced manner. Typically, the user shall first establish measurable values of deployment, mobility, mission frequency and duration, manpower and personnel skills, and service life. Later, the PM and the user shall translate these supportability factors into concrete values of reliability, maintainability, and affordability expressed in system performance terms. Requirements have to express what is needed and not how it must be achieved.

Both supportability and operational requirements should be termed as objective and threshold values, because the gap between them constitutes the PM tradeoff margin. Additionally, a reduced number of requirements should be identified as the crucial ones. If one of those requirements is not achieved, the whole system success is jeopardized.

Inclusion of Supportability as a Core Issue in Every Phase of the Project. The desired level of supportability must influence the system design and must determine the optimal set of logistics support resources to achieve user's needs during peace and war. To achieve this objective, two simultaneous actions must be executed according to the cases studied.

First, the PM responsibilities should be revised to include logistics support as one of his core responsibilities. It is not enough that the PM be a coordinator among logistics organizations if he has to assure cost-effective support for the system. Being intimately related to the operational goal achievement, supportability requirement satisfaction demands that the PM be the focal point for managing acquisition logistics.

Second, supportability issues must be assigned the same level of importance than operational ones, at every phase since the outset of the project. If there is no balance between operations and logistics influences on the decision-making process, the system successful implementation and use is imperiled. It is definitively too late if logistics issues become important only when the production phase arrives.

Acquisition Team Composition. As the evidence from the case studies presented in this research demonstrates, acquisition is primarily a logistics problem and a logistics activity. Consequently, logisticians must be the basis and the largest subgroup in any acquisition team, receiving collaborative contributions of users and operators.

Acquisition groups in the FAA should imitate the openness that characterizes the more advanced countries' systems. Users, maintainers, administrators, and even detractors of the new system are convoked to participate in integrated product teams with high degree of empowerment and training. Likewise, logisticians are a crucial part of all these groups at every decision level.

Acquisition Team Training. Those countries with the most advanced acquisition processes put a lot of careful effort in this subject. In the U.S. and Australia, all the members are objects of huge investments in specific acquisition training. It is an accepted truth that in capital equipment acquisition, consequences of a deficient decision caused by inadequate training are not only extremely expensive but also reverberates during the whole life of the system. Then, acquisition-training investments result in large savings and increased system efficiency. Spanish and Portuguese training efforts are increasing, but still elementary.

Without ignoring economic constraints affecting a small air force, the FAA should generate a group of acquisition specialists accrediting good training and experience. Acquisition training for these people must include contracting, logistics management, budgeting, teamwork techniques, R&M issues, and acquisition procedures from Argentina and those countries where the FAA buys most of its materiel. These personnel should constitute the basis of the most important acquisition programs, but their job must also involve providing training to other people. Specific courses dictated and sponsored by the Systems Directorate and/or the Materiel Command and courses/lectures at the Air Staff School (ESGA), the IUA, and the Air Academy (EAM) could be the means of providing basic training. Those who excel in these basic courses should be selected for advanced instruction locally and abroad. Opening a post graduate course in logistics covering acquisition aspects at the IUA should be analyzed, as well as outsourcing this service to other universities.

PM Chain of Command. A general tendency in the procedures of the studied countries indicates that the chain of command between the PM and the MDA must be reduced to a minimum number of links and complexity. Additionally, PM receives substantial decision leeway and proportional accountability for his/hers decisions.

Adapted to the FAA reality, a model repeatedly seen in this four-country case study indicates that the PM should organically report to the MDA through the Systems Director. Additionally, the PM should functionally report and inform to an Acquisition Committee, which determines broad guidelines for the project and advises the MDA about milestone approvals and project progresses. The Acquisition Committee should be chaired by the Deputy Chief of Staff and integrated by the Materiel Commander, the Personnel Commander, the Operations Commander or the user's commander, the Planning Chief of the General Staff, the Materiel Director, the Supply Director, and the Systems Director.

Advantages of such a scheme are:

- Reduced chain of command.
- Important decisions on a project are made and known by all the principal actors.
- The acquisition committee could act as the natural environment for collaborative effort decisions among different organizations and the project office.
- The MDA would receive multidisciplinary and more complete recommendations before each milestone completion decision.

Final Words

In my opinion, it is equally dangerous and senseless to reinvent the wheel than to copy foreign experiences without analysis. This research has been oriented to transit the frequently difficult road between these two extremes.

On the other hand, final proposals have been keep as general and simple as possible in order to avoid constraining a potential implementation. Advances made in implementation guidelines are mostly included as means of clarifying ideas.

Some of the proposed issues can be achieved with almost zero financial and human effort. On the other hand, there are other propositions requiring variable degrees of financial and human resources investment. In the FAA, those resources are usually scarce even for the most basic needs, and at the first glance, acquisition does not seem to be one of those basic needs. However, as an incentive to revise this first perception, it is relevant to take into account the following statement extracted from the final report of the Australian Defence Efficiency Review (Australian Department of Defence, 1997b: 25):

> The acquisition activity is disproportionately important in Defence, not merely because it spends the largest single discretionary sum of money, but also because what it buys forms the backbone of the ADF and determines its military capabilities for decades. The effectiveness of the organisation is overwhelmingly more important than its internal efficiency because poor procurement can cost far more, initially and over the life of the purchases, than any possible internal efficiency savings. Efficiencies are, of course, important in their own right, provided they do not adversely affect effectiveness.

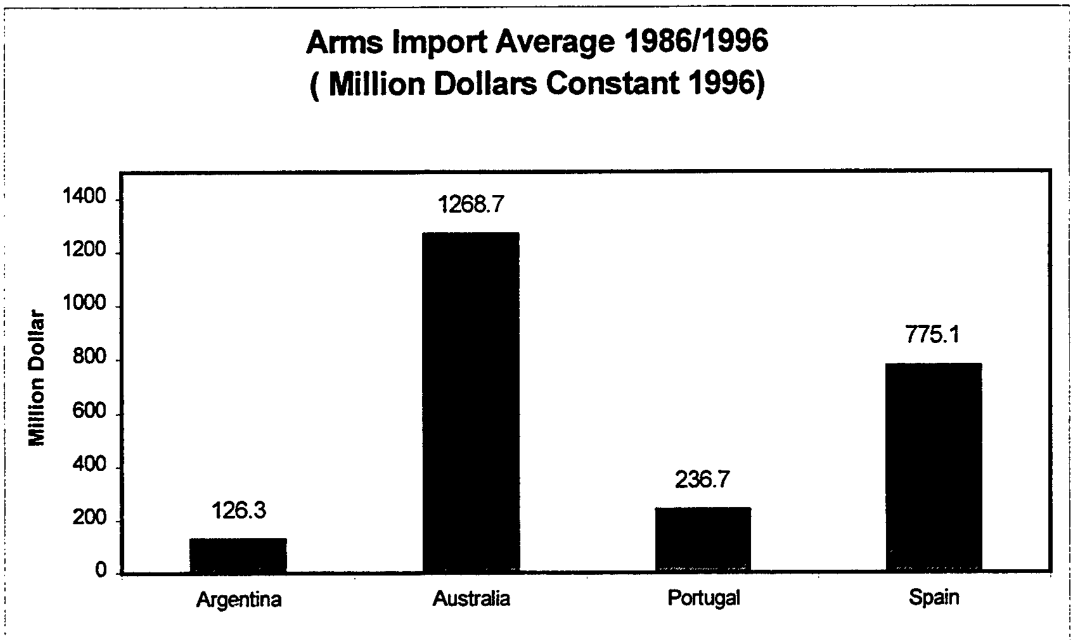
Opportunities for Further Research

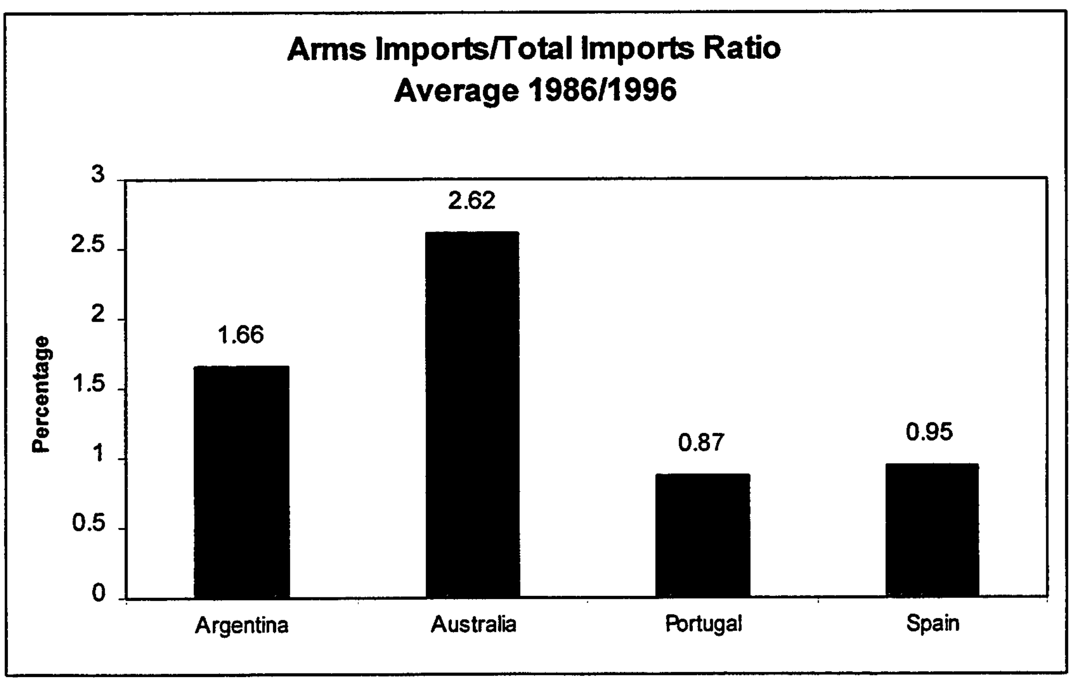
The analysis of the major system acquisition processes of other countries could provide new perspectives and could enrich current findings. Especially useful should be studying countries with some degree of similarity to Argentina, provided their acquisition systems be more evolved. In that group of countries could be Brazil, Canada, South Africa, and Mexico. Likewise, payoffs shall stem from the British, French, and German acquisition systems.

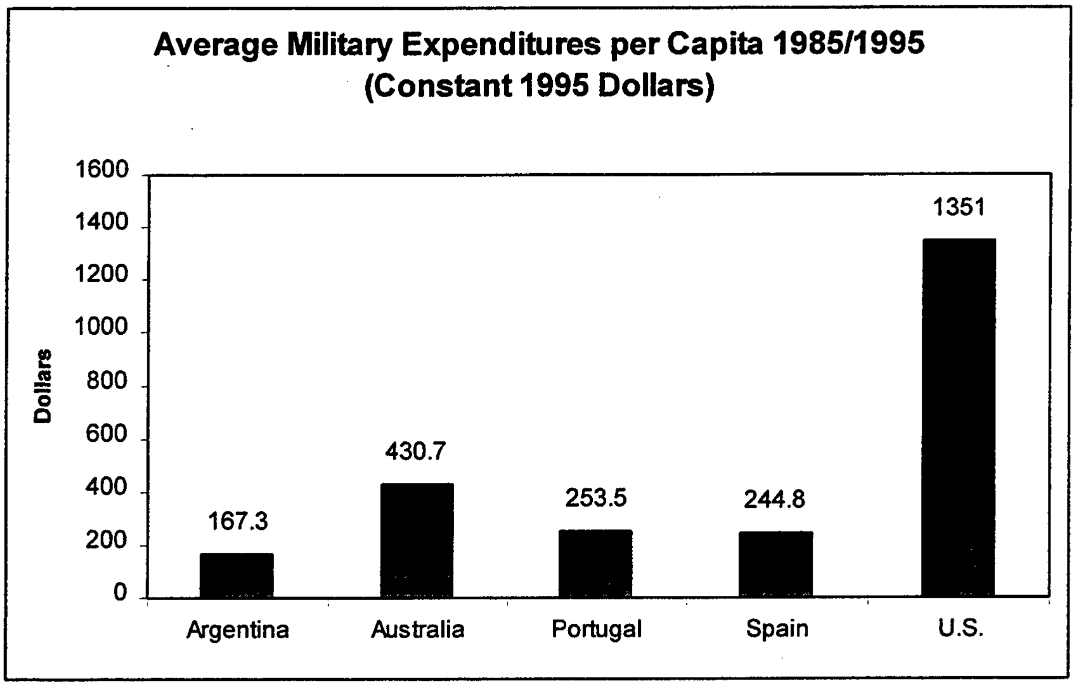
Other interesting aspect to be explored is the convenience for Argentina of adopting a joint acquisition system at the Ministry of Defense level, as several countries have, including Australia. The relatively small number of purchases and the increasing complexity and cost of the materiel involved give a good reason for grouping skillful personnel and financial efforts in one organization covering the needs of all the military and security services.

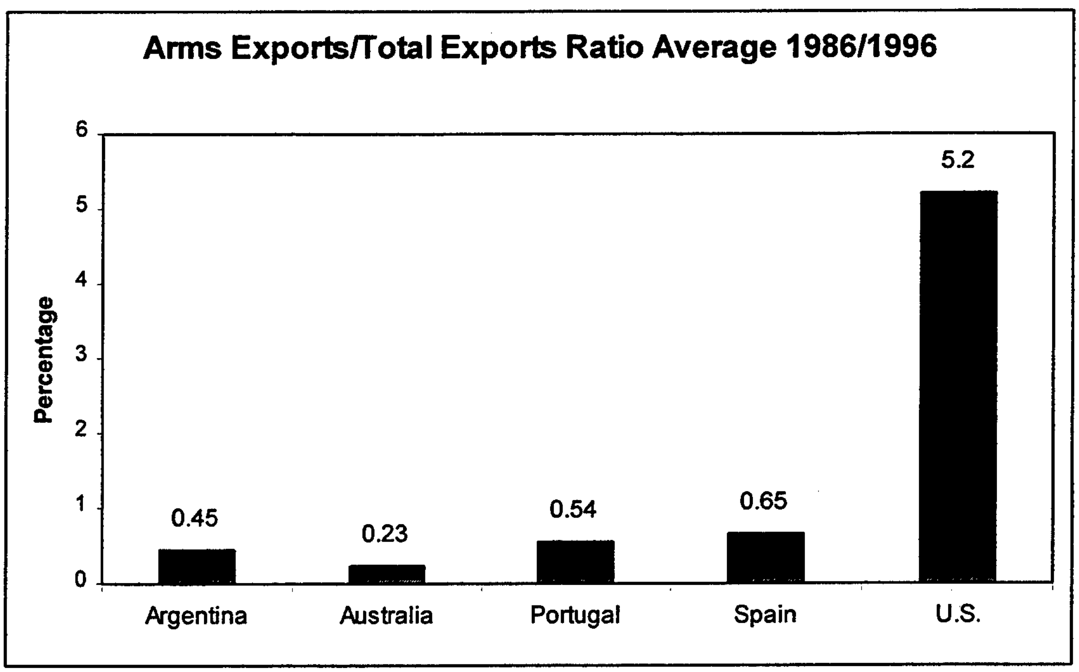
Appendix A

Military Acquisition Figure Comparisons among Selected Countries







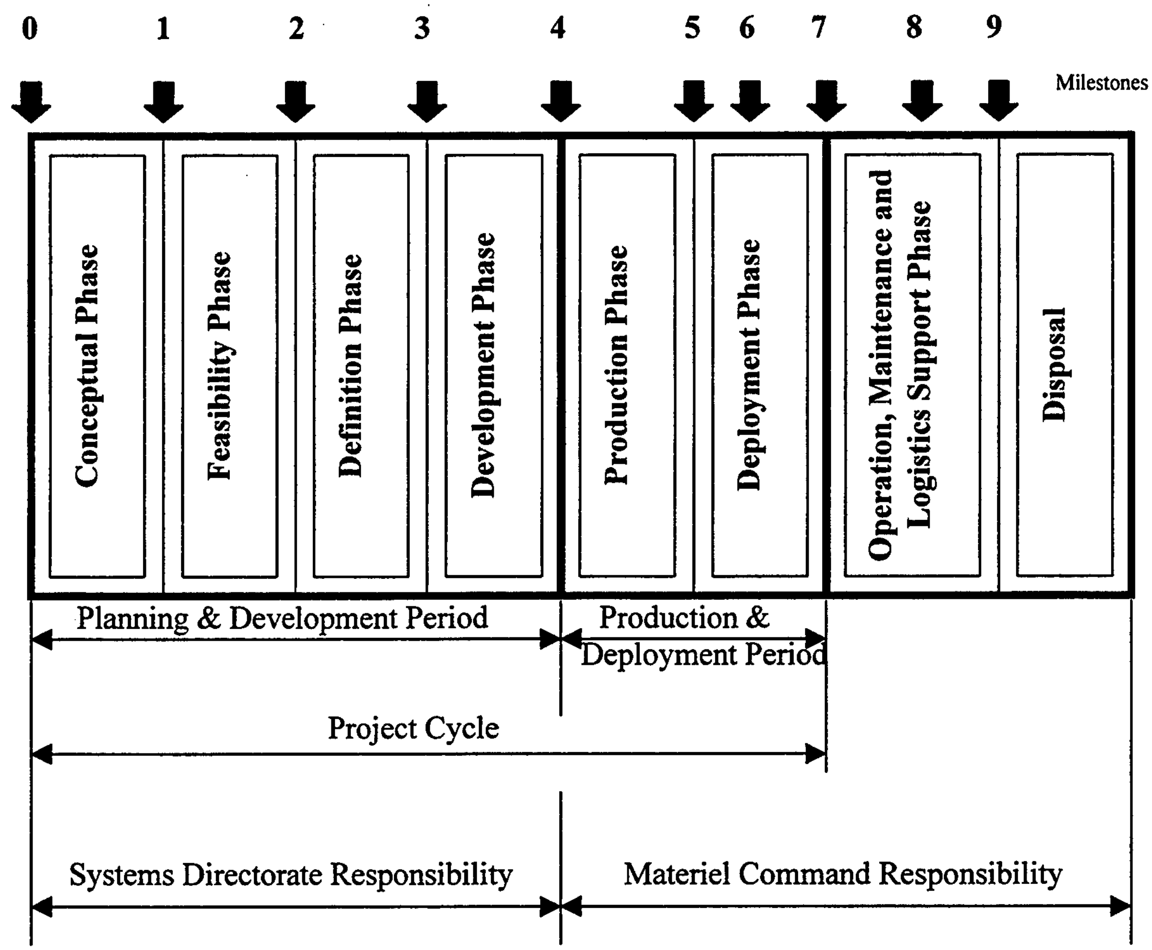


Sources:

- United States Arms Control and Disarmament Agency, 1998: 58, 87, 91, and 96.
- United States Arms Control and Disarmament Agency, 1999: Table II.

Appendix B

Argentine Air Force's Project Periods and Phases



Source:

Argentine Air Force, 1994: Annex 1

Appendix C

Australian Capital Equipment Procurement Manual Organization

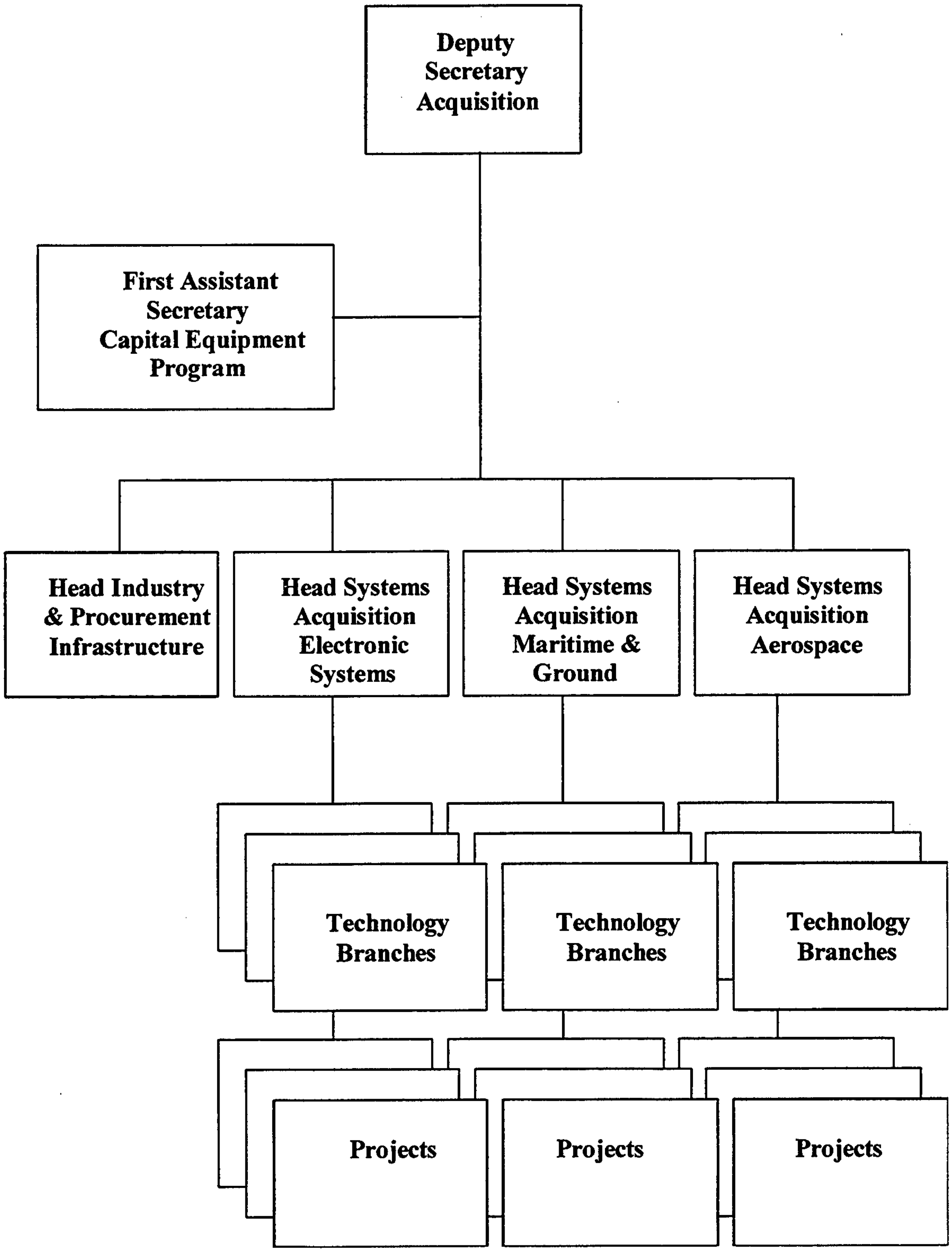
PARTS	CHAPTERS
1. An Introduction to Capital Acquisition	1- The CEPMAN-Authority, Application and Amendment. 2- Acquisition and Logistics-Objective, Organisation and Responsibilities 3- Outline of the Major Capital Equipment (MCE) Process 4-Consultation and the "Advise and Report Process. 5- Project Manager's Responsibilities 6- Principles and Techniques of Project Management 7- Relationships with Government, Other Defence Elements and the Public 8- The Role and Responsibilities of the Assistant Secretary Materiel (ASMAT) 9- Glossary of Terms 10- Financial Aspects of Project Management. 11- Official Conduct 12- MCE Acquisition Project Management Education and Training
2. Technical and Industry, Policy and Procedures	1- Defence Policy for Australian Industry 2- Australian Industry Involvement (AII) Programs in MCE Projects 3- Import to Australia of Foreign Controlled Dual-Use Technology and Defence Goods 4- Reserved 5- International Collaborative Arrangements in Major Defence Equipment Development Production and Procurement. 6- Controls on the Export of Technology with Civil and Military Applications 7- Controls on The Export of Defence and Related Goods and Dual-Use Goods 8- Standardisation 9- Warranties 10- Scientific Support for Capital Equipment Projects 11- Quality Assurance 12- Intellectual Property Management in Capital Equipment Projects 13- Assistance to Australian Exporters of Defence Products 14- Conduct of Test and Evaluation in Support of Capital Equipment Projects 15- Reserved 16- Relationship Between Project Managers and the Australian Ordnance Council

	17- Release Of US Sourced Sensitive Software 18- Reserved 19- Facilities Aspects Of MCE Projects 20- Information Technology Aspects Of MCE Projects 21- Customs Duty Aspects Of MCE Projects
3. Financial Policy and Procedures	1- Financial Management Plans 2- Contingency Provisions in Capital Equipment Projects 3- Management and Accounting of Receipts and Credits in the MCE Program 4- MCE Sub-Program-Financial Management 5- Cost Estimating in Capital Equipment Projects 6- Procurement Approvals 7- Project Approval and Variations to Project Approval 8- Determination of Variations for Project Cost Updates and Programming and Budgetary Estimates. 9- Programming of Liability and Expenditure for MCE Projects 10- Financial Management Records 11- Foreign Military Sales Procedures 12- Financial Considerations in MCE Project Tendering and Contracts 13- Release of Project Financial Information 14- Claims Payments Procedures. 15- Insurance in Capital Equipment Project Contracts 16- Project Risk and Management 17- Provision of Legal Services in Support of Major Equipment Projects 18- MCE Sub-Program Fraud Control Plan 19- MCE Sub-Program Audit Activities 20- MCE Aspects of Pre-approval Costs 21- Leasing 22- Accrual Reporting Requirements in Capital Equipment Projects 23- Preparation of Cost, Schedule and Programming Input for Project Executive Summaries.
4. Procurement Policy and Procedures	1- Equipment Acquisition Strategies 2- Project Management and Acquisition Plans (PMAP) 3- Invitations to Register Interest and Requests for Proposals 4- Request for Tender (RFT) and the Tender Evaluation Plan (TEP) 5- Tender Evaluation and Source Selection 6- Contract Negotiation 7- Management of MCE Contracts 8- Project Review and Reporting Procedures 9- Handover of Equipment and Closing a MCE Project 10- Reserved

	11- Types of MCE Contracts 12- Equipment Specifications, Drawings and Standards 13- Public Relations Aspects of MCE Projects 14- Seeking Waivers of Research and Development and Asset Use Charges in Defence Purchases in the US 15- Value Management Incentives in Capital Equipment Contracts 16- Acquisition Models 17- Relationships with Agents in Capital Procurement 18- Engagement of Consultants 19- Codification 20- Integrated Logistics Support for Capital Equipment 21- Computer Aided Acquisition and Logistics Support (CALS) 22- The Exchange of Cost/Schedule Control Systems Criteria in Capital Equipment 23- Evolutionary Acquisition 24- Application of Cost/Schedule Control Systems Criteria in Capital Equipment Contracts 25- Cost Schedule Status Reporting in Capital Equipment Contracts 26- Scheduling in Capital Equipment Contracts

Appendix D

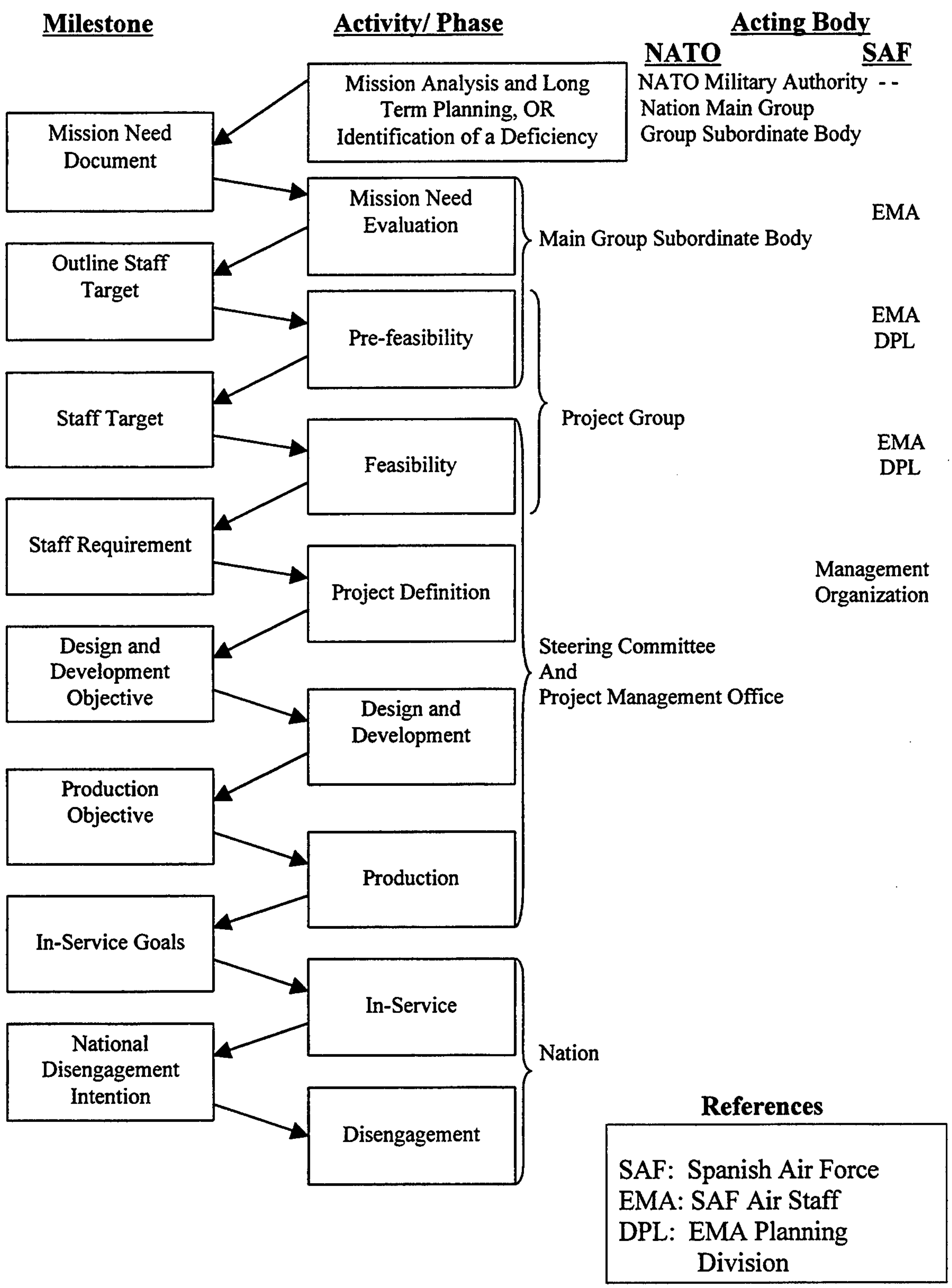
Australian DAO Organizational Structure



Source: Australian Department of Defence, 1999c

Appendix E

Phase Armament Programming System Overview



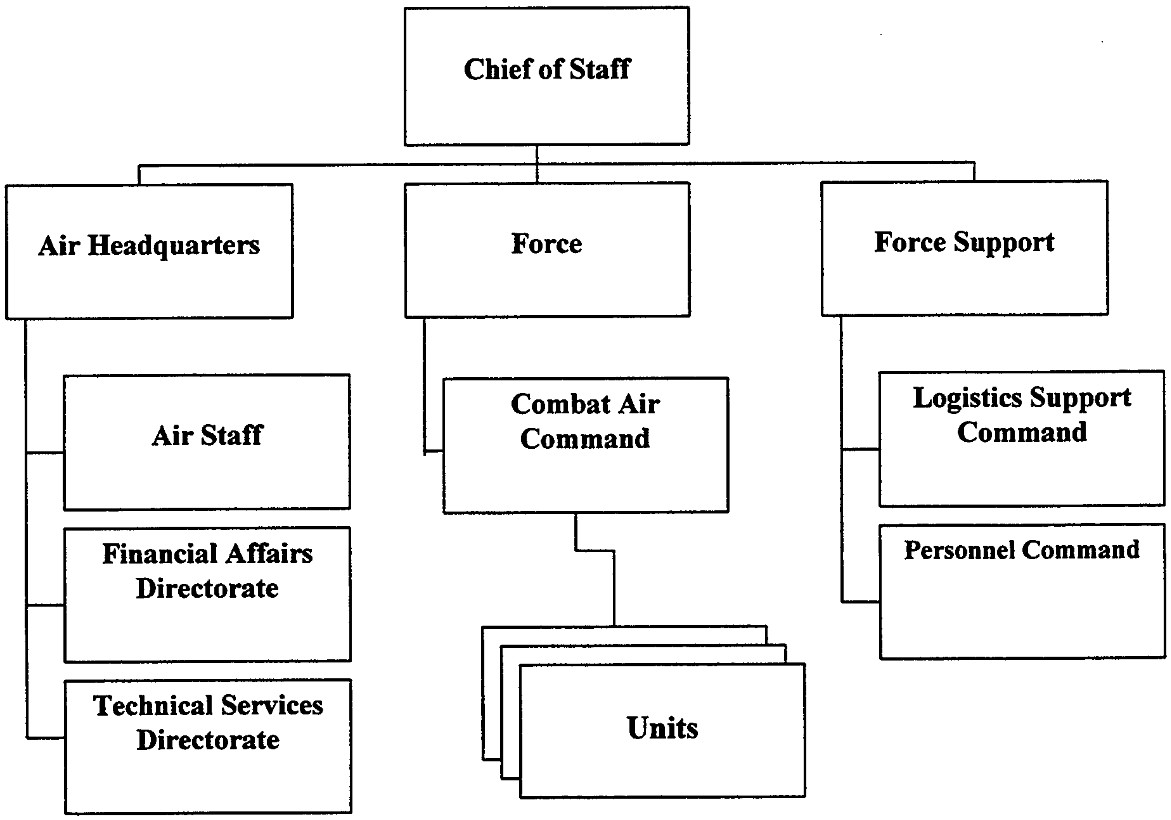
Sources:

- NATO International Staff, 1989: v.
- Spanish Air Force, 1993: Annex A.

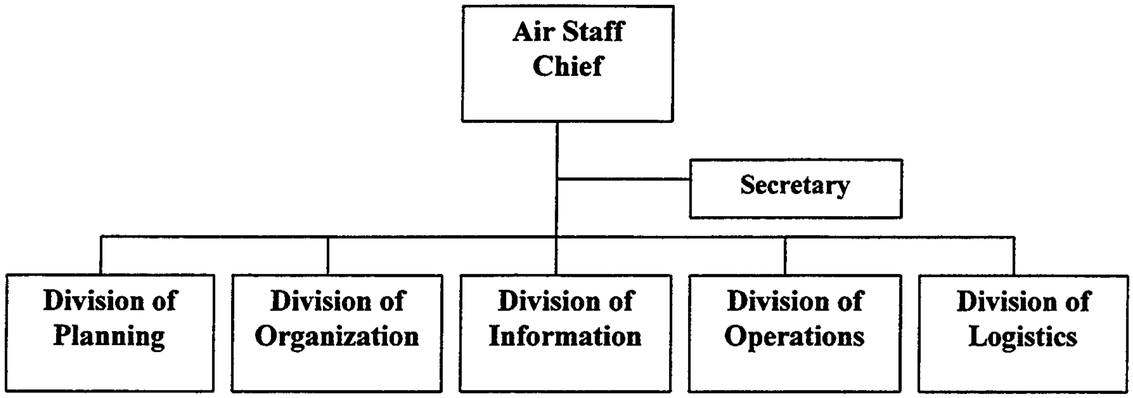
Appendix F

Spanish Air Force Organizational Charts

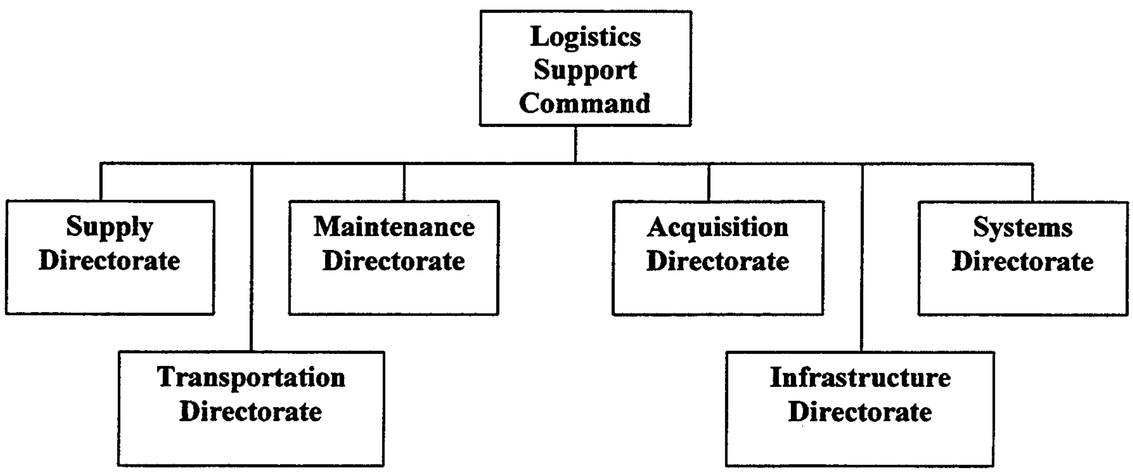
Spanish Air Force Organization



Air Staff Organization



Logistics Support Command



Source:

- Lombo López, 1997: 46
- Spanish Air Force, 1999.

Appendix G

Logistics Objectives in the U.S. Test and Evaluation Program

	ACQUISITION PHASE			
TEST TYPE	CONCEPT EXPLORATION & DEFINITION	PROGRAM DEFINITION & RISK REDUCTION	ENGINEERING & MANUFACTURING DEVELOPMENT	PRODUCTION, FIELDING, DEPLOYMENT & OPERATIONAL SUPPORT
DT&E	Select preferred system and support concepts	Identify preferred technical approach, logistics risks, and preferred solutions.	Identify design problems and solutions, including: -Survivability -Compatibility -Transportation -R&M -Safety -Human factors	Ensure production items meet design requirements and specifications. Ensure adequacy of system design changes.
OT&E AND SUPPO RTABI LITY ASSESS MENTS	Assess operational impact of candidate technical approaches. Assist in selecting preferred system and support concepts. Estimate operational compatibility and suitability.	Examine operational aspects of alternative technical approaches. Estimate potential suitability of candidate systems	Assess operational suitability: -Operational R&M -Built-in diagnostic capability -Transportability Evaluate logistics supportability: -Effectiveness of maintenance planning -Appropriate personnel skills/grades -Appropriate spare and repair parts, bulk supplies. -Adequate SE, including effective ATE and software. -Accurate and effective technical data; validation/verification of technical manuals. -Adequate facilities (space, environmental systems, storage) -Effective packaging, lifting devices, tie-down points, transportation instructions.	Ensure production items operational suitability requirements. Demonstrate attainment of system readiness objectives. Update O&S cost estimation. Evaluate operational suitability and supportability of design changes. Identify improvement required in supportability parameters. Provide data required to adjust ILS elements

Source: Defense Systems Management College, 1997a: Ch 11, 3)

Appendix H

Vita of Lieutenant Colonel Fernando Pastor Villar (Spanish Air Force)

Lt. Col. Fernando Pastor Villar was born on 4 June 1954 in Seville, Spain. He graduated from the Spanish Air Force Academy, San Javier in 1978. After graduation, he was selected for a Cargo Pilot Course.

His first tour of duty was at Torrejón Air Force Base. Later, he served as a flight instructor at the Spanish Air Force Academy. He was promoted to Major in 1990 and commanded the Primary Flight School and later the Squadron of Cadets.

In 1994, Lt. Col. Pastor Villar was selected to attend the Air Staff Course. After graduation one year later, he was assigned to the Logistics Division in the Air Staff Headquarter in Madrid.

In May 1996, he entered the Graduate School of Logistics and Acquisition Management, Air Force Institute of Technology at Wright-Patterson AFB, Ohio. In June 1998, he graduated from the Logistics Management Program.

After returning to Spain, he became chief of the Materiel Section in the Logistics Division of the Air Staff Headquarter, position that he holds nowadays.

Appendix I

Vita of Colonel Saul António Dias Pascoal (Portuguese Air Force)

Col. Saul Pascoal was born at Ourem, Portugal on March 16, 1949. He attended to Elementary School at his hometown, and after that, he moved to Lisbon, where he graduated from High School at age of seventeen.

In 1972, he graduated as an Aeronautical Engineer from the Military Academy, and was promoted to Lieutenant.

In 1975, Col. Pascoal was promoted to Captain, and in 1980 to Major, after attending the Officer Staff Course. In 1975, he ascended to Lt. Colonel and in 1985 to Colonel.

He has been the Portuguese Liaison Officer (FLO) at AFSAC since 1996. According to Portuguese regulations, he is not only responsible for the FMS acquisition process, but also for the FAP commercial procurement in the United States.

From 1990 to his assignment as FLO, he was the F-16 Program Manager for the FAP.

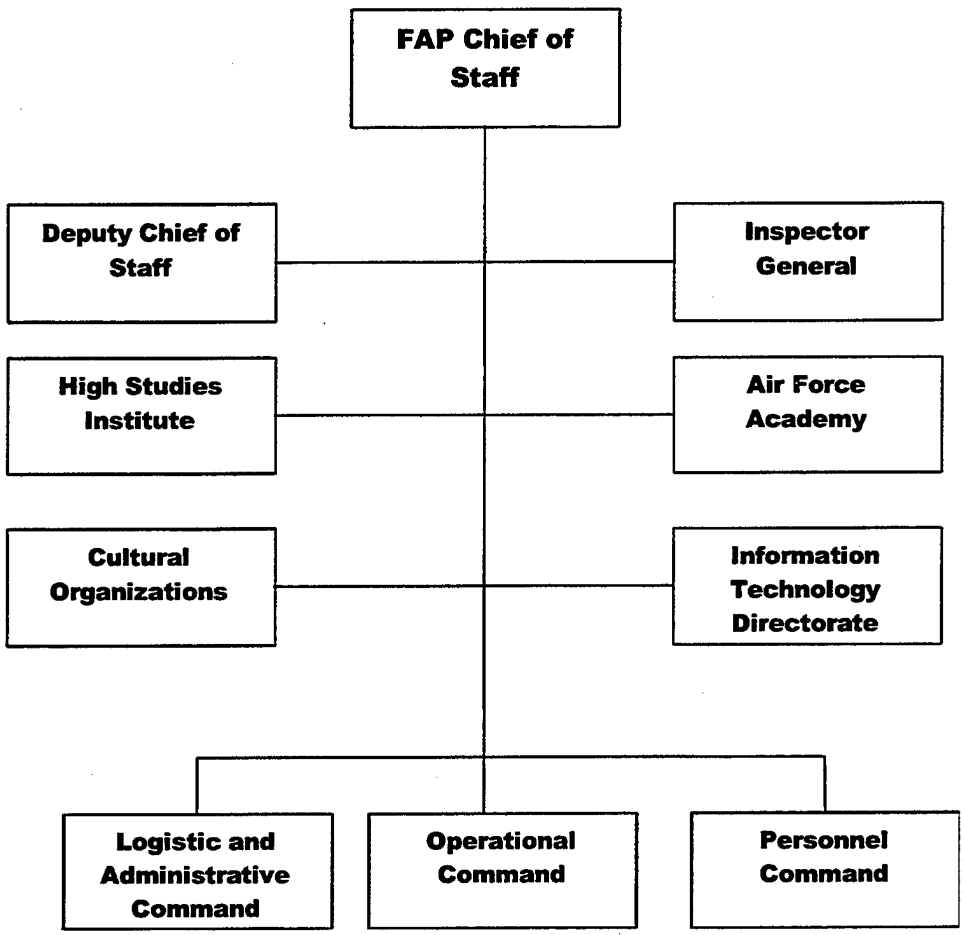
Col. Pascoal was the Deputy Commander for Maintenance at Air Base 4 in the Azores Islands, during the 1987/1989 period.

In 1979, he was assigned as the Deputy Liaison Officer at LTV-Dallas for the Portuguese A-7P Program, living in the United States for 18 months. In 1981, back in Lisbon, he was the Supply Manager for this Program.

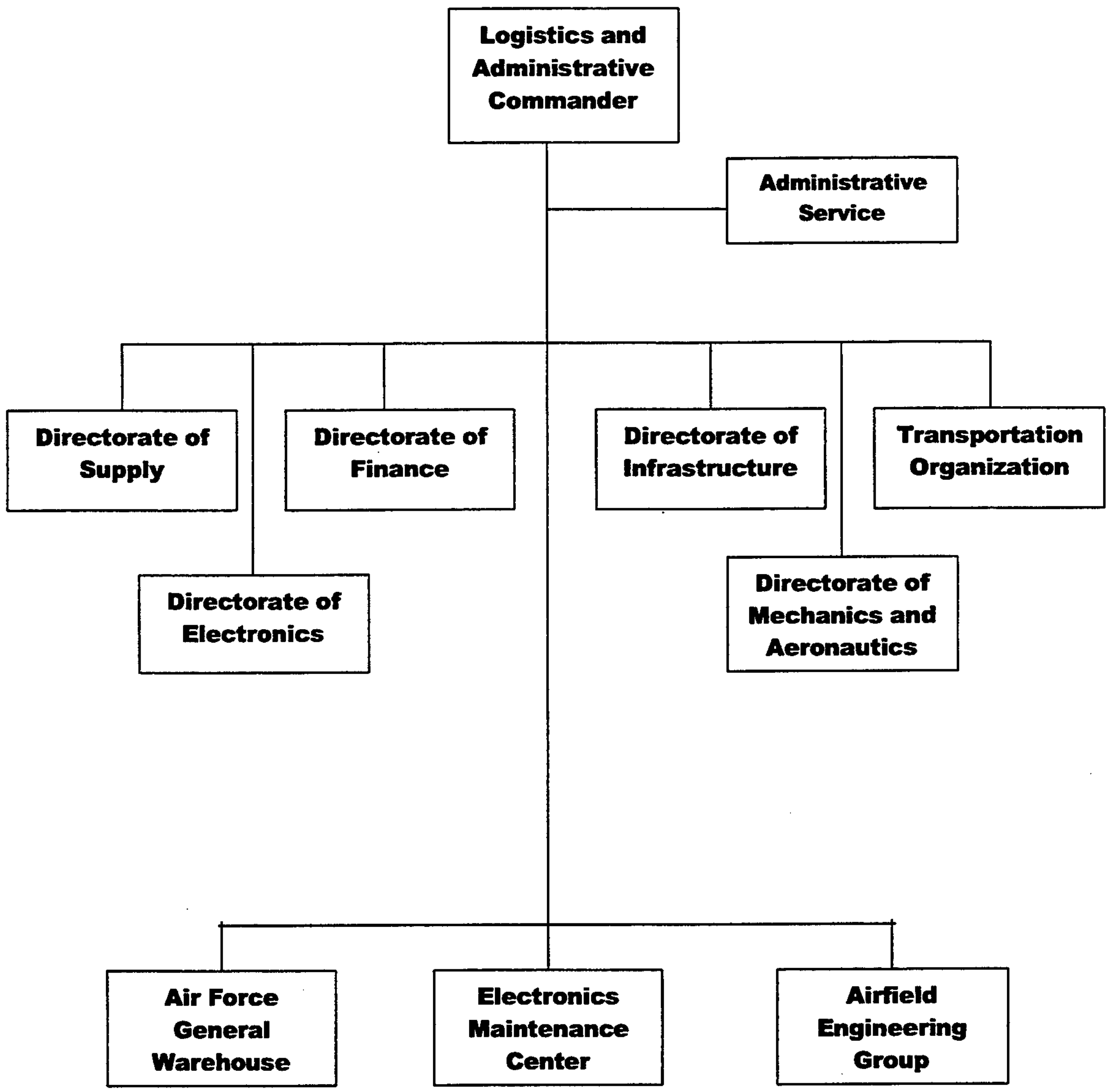
Appendix J

Organizational Structures of the Portuguese Air Force

FAP Organizational Structure



Logistics and Administrative Command Organizational Structure

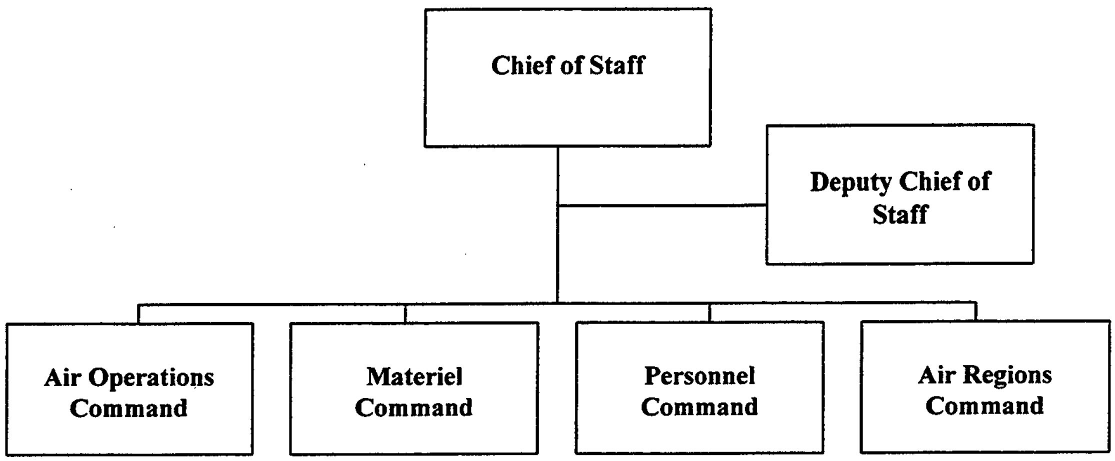


Source: Portuguese Air Force, 1999.

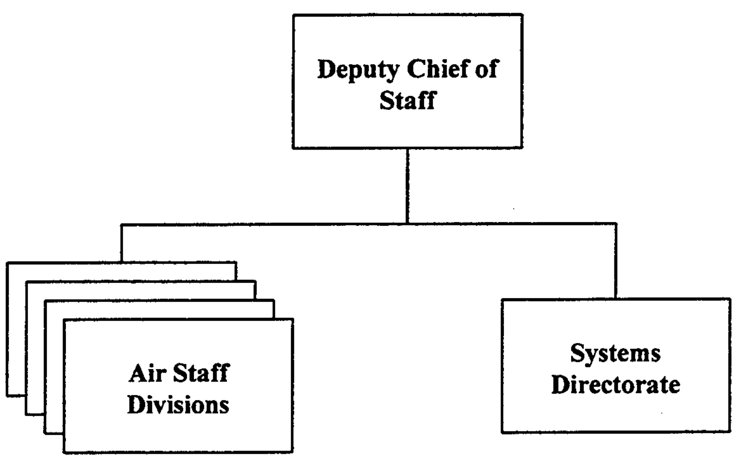
Appendix K

Argentine Air Force Organizational Charts

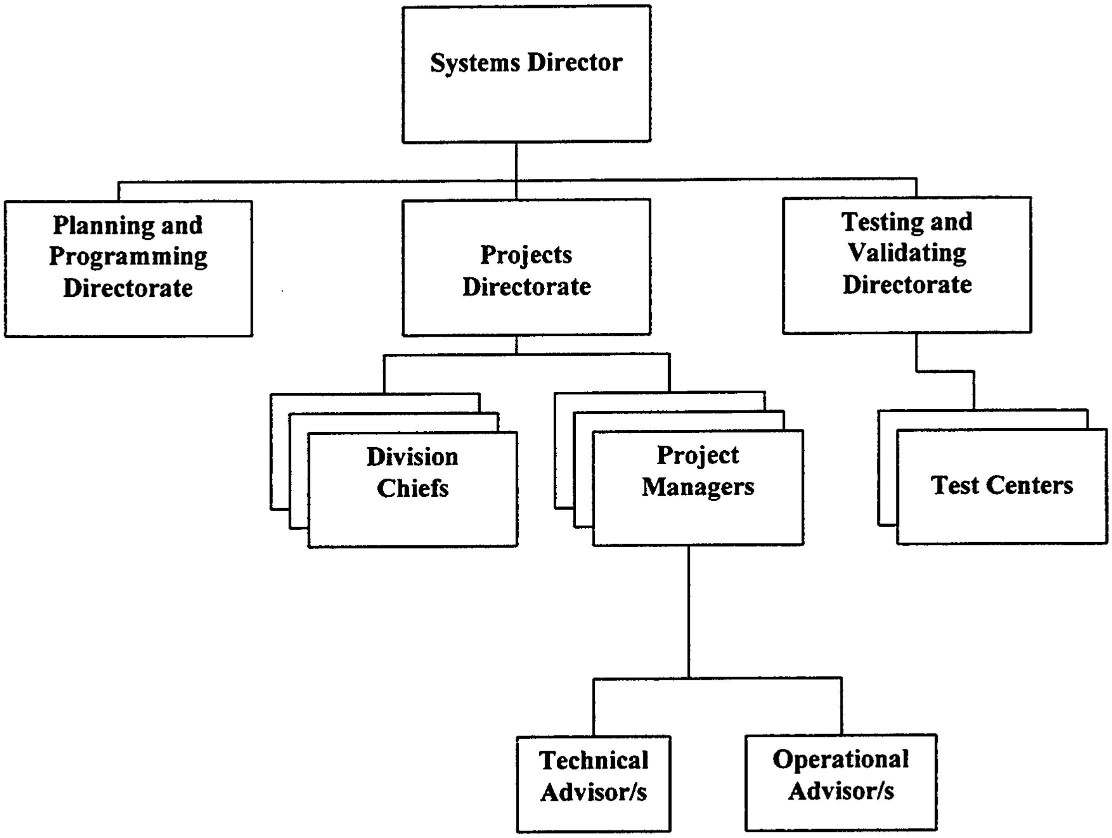
Argentine Air Force Organization



Deputy Chief of Staff Organization (simplified)



Systems Directorate Organization



Sources:

- Argentine Air Force, 1999.
- Argentine Air Force, 1994: Annex 6.

Appendix L

Glossary of Acronyms and Abbreviations

A:	Availability
Aa:	Achieved Availability
A&L:	Acquisition and Logistics
ACAT:	Acquisition Category
ADF:	Australian Defence Forces
AECMA:	European Association of Aerospace Materiel Manufacturers
AFARMADE:	Spanish Association of Defense Materiel Manufacturers
AFSAC:	Air Force Security Assistance Center
Ai:	Inherent Availability
AII:	Australian Industry Involvement
AIS:	Automated Information System
Ao:	Operational Availability
APB:	Acquisition Program Baseline
APDP:	Acquisition Professional Development Program
ATE:	Automated Test Equipment
CAIG:	Cost Analysis Improvement Group
CAIV:	Cost as an Independent Variable
CAE:	Component Acquisition Executive
CALS:	Computer Aided Logistics Support
CBPF:	Portuguese Biannual Force Planning Cycle
CEP:	Capital Equipment Program
CEPMAN:	Australian Capital Equipment Procurement Manual
CIO:	Chief Information Officer
CNAD:	NATO's Conference of Armament National Directors
CONUS:	Continental United States
CPIPT:	Cost/Performance Integrated Product Team
C/SCS:	Cost/Schedule Control System
C/SCSC:	Cost/Schedule Control Systems Criteria
DAB:	Defense Acquisition Board
DAE:	DoD Acquisition Executive
DAO:	Australian Defence Acquisition Organisation
DARB:	Defence Acquisition Review Board
DAU:	Defense Acquisition University
DAWIA:	Defense Acquisition Workforce Improvement Act
DCC:	Defence Capability Committee
DEFPUR:	Australian Proforma Request for Tender
DEPSEC-A:	Deputy Secretary Acquisition
DEPSEC-S&I:	Deputy Secretary Strategy & Intelligence
DER:	Australian Defence Efficiency Review
DoD:	U.S. Department of Defense

DoDD:	Department of Defense Directive
DPL:	Planning Division of the Spanish Air Force's Air Staff
DPPM:	Australian Defence Procurement Policy Manual
DRP:	Australian Defence Reform Program
DSSB:	Defence Source Selection Board
DT&E:	Development Test and Evaluation
EAM:	Argentine Air Force Academy
EAS:	Equipment Acquisition Strategy
ECP:	Engineering Change Proposal
EF2000:	Euro Fighter 2000 Aircraft
EMA:	Spanish Air Force's Air Staff
EMD:	Engineering and Manufacturing Development
ESGA:	Argentine Air Force Staff School
FAA:	Argentine Air Force
FAP:	Portuguese Air Force
FASCEP:	First Assistant Secretary, Capital Equipment Program
FLA:	European Future Large Aircraft
FLO:	Foreign Liaison Officer located within CONUS
FMA:	Former Argentine Military Aircraft Factory
FMECA:	Failure Modes and Effects Criticality Analysis
FMS:	Foreign Military Sales
FOT&E:	Follow-On Test and Evaluation
FRACAS:	Failure Reporting, Analysis, and Corrective Action System
GFE:	Government Furnished Equipment
JROC:	Joint Requirements Oversight Council
KPP:	Key Performance Parameter
ILS:	Integrated Logistics Support
ILSM:	Integrated Logistics Support Manager
ILSMT:	Integrated Logistics Support Management Team
ILSP:	Integrated Logistics Support Plan
ILSTWG:	Integrated Logistics Support Task Working Group
IPPD:	Integrated Product and Process Development
IPT:	Integrated Product Team.
IUA:	Argentine Air Force Aeronautical University Institute
LCC:	Life Cycle Cost
LEM:	Logistic Element Manager
LM:	Logistics Manager
LPM:	Portuguese Military Programming Act
LRU:	Line Replaceable Unit
LSA:	Logistics Support Analysis
MAIS:	Major Automated Information System
MALOG:	Spanish Air Force's Logistics Support Command
MAPER:	Spanish Air Force's Personnel Command
MCE:	Major Capital Equipment
MCS:	Major Capability Submission

MDA:	Milestone Decision Authority
MDAP:	Major Defense Acquisition Program
MLDT:	Mean Logistics Down Time
MMT:	Mean Maintenance Time
MND:	Mission Need Document
MNS:	Mission Needs Statement
MOE:	Measure of Effectiveness
MOP:	Measure of Performance
MTBF:	Mean Time Between Failure
MTBM:	Mean Time Between Maintenance
MTTR:	Mean Time To Repair
NDI:	Non-Developmental Item
OIPT:	Overarching Integrated Product Team
O&S:	Operations and Support
ORD:	Operational Requirements Document
OSD:	Office of the Secretary of Defense
OT:	Operating Time
OT&E:	Operational Test and Evaluation
PAPS:	Phase Armaments Programming System
PDRR:	Program Definition and Risk Reduction
PEO:	Program Executive Officer
PHS&T:	Packaging, Handling, Storage, and Transportation
PM:	Program Manager
PMO:	Program Manager Office
PMAP:	Project Management Acquisition Plan
PMET:	Project Management Education and Training
RAAF:	Royal Australian Air Force
RAM:	Reliability, Availability, and Maintainability.
RFP:	Request for Proposal
RFT:	Request for Tender
R&M:	Reliability and Maintainability
RO:	Argentine Air Force's Operational Requirement
SAF:	Spanish Air Force
SE:	Support Equipment
SE:	Systems Engineering
SER:	Source Evaluation Report
SL2000:	Spanish Air Force's Integrated Logistics System
SOO:	Statement of Objectives
SOR:	Statement of Requirement
SOW:	Statement of Work
SRU:	Shop Replaceable Unit
T&E:	Test and Evaluation.
TAFT:	Test, Analyze, Fix, and Test
TCM:	Corrective Maintenance Time
TDR:	Tender Deliverable Requirement

TEMP:	Test and Evaluation Master Plan
TEP:	Tender Evaluation Plan
TPM:	Preventive Maintenance Time
USAF:	United States Air Force
USD(A&T):	Under Secretary of Defense for Acquisition and Technology
VCDF :	Vice Chief of the Defence Force
VMCP:	Value Management Change Proposal
VMIP:	Value Management Incentive Program
WIPT:	Working-Level Integrated Product Team
WOL:	Whole-of-Life [Costs]

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Vita

Major Guillermo Abel Piuzzi was born on 4 March 1959 in Jesús María, Province of Córdoba, Argentina. He graduated from *Liceo Militar General Paz*, his high school, in 1975 and from *Escuela de Aviación Militar*, the Argentine Air Force Academy, in 1979. He earned a degree as an Aeronautical and Mechanical Engineer from *Escuela de Ingeniería Aeronáutica* in Córdoba during December 1982.

His first assignment was at *Area de Material Río Cuarto*, which is one of the Argentine Air Force logistics centers. He spent there eleven years as Engineering Department Chief and as Maintenance Squadron Commander.

He entered *Escuela Superior de Guerra Aérea*, the Argentine Air Force War College, in February 1994. Upon graduation in December 1995, he received the Staff Officer qualification. While at *Escuela Superior de Guerra Aérea*, he also earned a Master of Business Administration degree in Enterprise Management jointly from the *Universidad del Salvador*, Buenos Aires, and the *Universidad de Deusto*, Bilbao, Spain.

When he was working in the Materiel Command HQ in Buenos Aires, he was selected to attend a Master of Science course in Logistics Management in the United States of America. Major Piuzzi entered the Graduate School of Logistics and Acquisition Management, US Air Force Institute of Technology at Wright-Patterson AFB, Ohio in April 1997. After graduation, he was reassigned to the Materiel Command HQ.

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Increasing costs, complexity and demanded endurance have been typical characteristics of new weapon systems during the last decades. Meanwhile, severe contraction of defense budgets makes cost effective and well-planned acquisition crucial to ensure weapon system whole life supportability.

This qualitative research explores the role of acquisition logistics in the endeavor of purchasing effective, efficient, and supportable systems in four countries, namely the United States, Australia, Spain, and Portugal. Through a multiple case study, a set of concepts is extracted and adapted to be proposed as the basis of a prospective Argentine Air Force weapon system acquisition process review.

Suggested improvements reside in three areas. First, doctrine should incorporate the integrated logistics support, life-cycle costs, and reliability and maintainability concepts to the acquisition practices. Second, procedures should include well-defined supportability requirements and should recognize supportability as a core issue in every project phase. Finally, from the organizational standpoint, the Argentine Air Force should consider revising the composition, training, and chain of command of its acquisition teams in order to optimize and facilitate those groups' actions.

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